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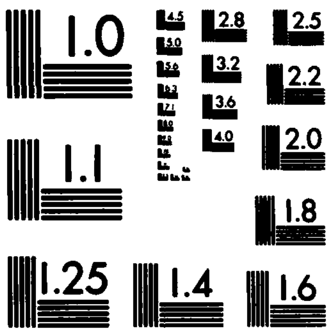

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ELECTRONIC EQUIPMENT MAINTENANCE TRAINING (EEMT) SYSTEM: DEVELOPMENT OF TEST AND EVALUATION SYLLABUS AND CURRICULA

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NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
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The electronic equipment maintenance training (EEMT) system is being developed to augment electronics-oriented training at the "A" school level. It is intended to reduce reliance on the use of actual equipment trainers (AET) and to provide a vehicle for practicing generic and representative electronic equipment preventive and corrective maintenance procedures by means of self-paced computer-assisted and computer-managed instruction. This report describes the development of a syllabus to support

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EEMT system test and evaluation (T&E) in two Navy electronics training Class "A" schools. It contains curriculum outlines for three functional (generic) systems and three representative systems used to develop lesson specifications for system T&E implementation.

FOREWORD

This effort was conducted under contract with Instructional Science and Development, Inc. in support of Navy decision coordinating paper Z0789-PN, subproject .01 (Class "A" Electronic Equipment Maintenance Training (EEMT) System). Its sponsors were the Deputy Chief of Naval Operations (OP-115 and OP-98) and the Deputy Chief of Naval Material (MAT-08E1). The objective of the subproject is to demonstrate the concept of a training simulator having broad applications in the field of electronic equipment maintenance training.

This report, the tenth in a series of Center reports concerning the EEMT system prototype development, describes the EEMT system test and evaluation syllabus development and provides documentation required for the production and implementation of EEMT specific lessonware. Five of the previous reports (NPRDC TR 80-30, TR 81-9, SR 82-17, TN 82-6, and TR 83-28) described the generalized maintenance trainer simulator (GMTS), which was used as the design model for the EEMT two-dimensional system component. The other four described the EEMT concept formulation, system definition, system test and evaluation, system design characteristics as compared to a number of alternative hardware approaches used in teaching electronic maintenance techniques to Navy enlisted personnel, and system life cycle cost (NPRDC TN 79-3, TR 81-11, SR 81-19, and SR 82-33).

Appreciation is expressed to the following for their cooperation and assistance during the data collection for this development task:

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Technical Director

SUMMARY

Problem

The use of operational equipment as a primary training medium in Navy electronics-oriented Class "A" schools can be costly, dangerous, inflexible, and pedagogically invalid. Thus, the Navy has initiated an engineering development, test, and evaluation effort to develop an electronic equipment maintenance training (EEMT) system capable of reducing dependence on the use of operational equipment in class "A" schools. The training system will provide (1) a capability for transitioning between the fundamental theory-oriented parts of the curriculum and the specific equipment training that follows, and (2) an alternative to actual equipment trainers for extended practice in equipment operations and troubleshooting procedures. Training syllabi and lessonware specifications are needed to support lessonware development for EEMT system test and evaluation (T&E).

Objective

The EEMT project is being conducted in four phases: (1) concept formulation, (2) system definition, (3) prototype development, and (4) system T&E. The objective of the work described herein, which was conducted as part of Phase III, was to develop curriculum outlines and lesson specifications for EEMT prototype system implementation, test, and evaluation at the electronics technician (ET) and electronics warfare technician (EW) class "A" schools.

Approach

Preliminary T&E syllabi were prepared based on the results of electronics equipment commonality, task, and training requirements analyses completed as a part of Phase II, system definition. A methodology called estimate-talk-estimate (E-T-E), which represents a modified Delphi technique, was used to review and finalize functional and representative equipment T&E curriculum outlines. Interviews were conducted with ET and EW "A" school instructors and training managers, and questionnaires were prepared to review and critique individual training objectives on a systematic basis. The preliminary syllabi were revised to reflect school inputs and constraints, and lessonware specifications were prepared in a format consistent with projected EEMT system hardware and software capabilities.

Results

Final curriculum outlines and corresponding lesson specifications were developed for three generic and three representative equipments to support EEMT system T&E in the ET and EW Class "A" schools. Individual lessons represent a combined total of approximately 208 EEMT system contact hours. Only 26 of 40 major enabling objectives, identified during the project system definition phase as "common-core" ET and EW objectives, were used in developing final generic equipment syllabi. Common-core enablers and specific equipment objectives were selectively applied within the individual syllabi to accommodate practical differences in training found to exist between the two target schools. Instructional and performance evaluation algorithms were developed to guide the preparation of lesson materials for all included objectives.

Conclusions

1. Lessons selected for use during EEMT project T&E constitute a reasonable but limited sampling of ET and EW school common-core and equipment-specific objectives suitable for implementation of two- and three-dimensional (2D/3D) trainer components. Project goals for developing a single, common-core, generic curriculum for implementation at the two training sites were met with only marginal success.

2. The assumption of compatibility of objectives between the two target schools proved to be invalid in approximately 75 percent of all specific instances tested. These results were attributed in part to the divergence in job task requirements found to occur between families of electronics equipment when progressing from the functions/component level to higher-order task levels within a hardware system. Other curriculum differences between the two target schools, which represent major variations in training approach and instructional emphasis, contributed significantly to the low percentage of common-core objectives that could be singularly implemented. Resolution of these differences would require the adaption of a standardized curriculum approach within the electronic training community.

3. Given the range and diversity of objectives included in the EEMT system T&E syllabi, it appears that the selected 2D/3D approach to simulation for maintenance training affords great flexibility of applications and can be successfully integrated into a variety of existing electronic-oriented training programs. It is anticipated that the EEMT system can be used most effectively in the area of training fault isolation skills.

Recommendations

1. It is recommended that OP-115 alter the EEMT system T&E effort to allow for the implementation of a stand-alone test of the generic systems maintenance training concept.

2. It is recommended that the Chief of Naval Technical Training (CNTT) provide one or two EEMT 2-D trainers/simulators to the training site a minimum of 6 months prior to installation. These units would be used for instructor familiarization and for assisting in simulation and training data base development and/or validation.

3. It is recommended that CNTT consider expansion of the representative equipment T&E syllabi to allow for full EEMT system implementation in the respective Class "A" schools at the earliest possible time.

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INTRODUCTION

Problem

Navy electronic-oriented Class "A" schools play a central role in supplying trained maintenance personnel to support fleet operational readiness. Traditionally, operational equipment is first introduced for hands-on and troubleshooting training at the "A" school level. However, with the rapid advances currently being made in engineering technology and the corresponding higher cost of systems acquisition and support, the continued use of operational prime equipment for basic procedural skills training is becoming less practical or desirable. In many instances, the equipment now being used to support "A" school maintenance training is obsolete and not always available in sufficient quantities to meet specific training needs. Additionally, when used as a training medium, operational equipment can be dangerous, inflexible, and pedagogically invalid. Analysis of equipment maintenance task commonality and electronic maintenance personnel utilization patterns suggest that a significantly different applications concept might be employed within the Class "A" schools. This concept would attempt to capitalize on the high degree of common maintenance tasks found to exist among electronic equipments and centralize the subject matter to "generic systems."

To investigate the feasibility of generic maintenance training in the Class "A" school, the Navy initiated a four-phase research, development, test, and evaluation effort for a generic (having general application) electronic equipment maintenance training (EEMT) system. The prototype system will ultimately be evaluated as to its ability to reduce dependence on the use of actual equipment trainers (AET) in the target schools and the effectiveness of the generic training approach. Training syllabi are required to facilitate the overall system test and evaluation (T&E) process.

Objective

The objective of this research was to develop EEMT-specific curriculum outlines and lesson specifications that would:

1. Include generic maintenance skills; that is, skills that generalize to a wide range of equipments maintained by the electronics technician (ET) and electronics warfare technician (EW) ratings.

2. Incorporate tasks that are common to both ET and EW ratings.

3. Incorporate maintenance tasks and skills that will transfer to actual equipment.

4. Provide a "top-down" approach to maintenance training.

5. Permit smooth integration of EEMT lessons into the existing training pipeline.

6. Accommodate school constraints.

7. Ensure compatability with EEMT prototype capabilities.

8. Provide sufficient detail to allow for the development of generic and representative equipment lessons.

9. Facilitate EEMT system T&E.

Background

EEMT Project

The EEMT project was initiated in response to Operational Requirement (OR) PN-50 of 26 July 1976. The research is being conducted in four phases: concept formulation, system definition, prototype development, and system T&E. The project is currently in the prototype development phase during which the system will be produced in sufficient quantities to permit in-service testing and assessment of both hardware and training capabilities. During Phase I, concept feasibility was confirmed and a basic system design approach was formulated (Wylie & Bailey, 1978). The ET and EW Class "A" schools were designated as the target users of the prototype system. Phase II, system definition, involved completing six separate tasks, four devoted to the fundamental design and T&E of EEMT hardware and two to the training aspects of the system (Pine, Daniels, & Malec, 1981; Pine, Koch, & Malec, 1981). The latter two tasks focused on the identification of generic maintenance operations and the analysis of training requirements. The purpose was to identify common ET and EW electronic equipment and maintenance tasks and to translate these data into lesson objectives to guide EEMT T&E curriculum development.

To accomplish the training analysis goals, three tasks were performed with the results of each being used as input for the next: (1) an equipment commonality analysis, (2) a task commonality analysis, and (3) a training requirements analysis. A taxonomy consisting of four levels--system, equipment, components, and modules--was developed for the equipment commality analysis. Specific types of electronic equipments were then examined to define the components that were common (i.e., could be expected to be encountered by personnel from both the ET and EW ratings).

Commonality across equipment was first tabulated in a systems/equipment by component matrix. Analysis of this matrix demonstrated that all equipment in the ET/EW sample could be described in terms of six generic components: antenna, receiver, transmitter, power supply, control/monitor, and digital processor. A more detailed analysis (Pine, Daniels, & Herringa, 1979) was then performed for each component by tabulating the commonality of generic modules across equipment in a system/equipment by component/module matrix. A generic module was here defined as a collection of parts that perform a particular electronic function (i.e., oscillator, multivibrator, amplifier, etc.). The results of this latter analysis indicated that there is significant diversity in the kinds of modules used to build a given component. This diversity, as measured by the percentage of equipment using a given generic module, also varies considerably from component to component. For example, in receivers, 50 percent of the generic modules were used in at least 20 percent of the equipment in the ET/EW sample. For transmitters, only 10 percent of the generic modules were used in 20 percent of the equipment in the sample.

Percentages computed as part of the matrix analyses were found to provide a useful index of commonality. Despite the variation in commonality across components, it was determined that the average module was common to almost 20 percent of all equipment in the hardware sample. It was therefore concluded that a trainer containing the generic components and modules defined during this phase of the research would have general applicabiity in either the ET or EW "A" schools.

The task commonality analysis was then undertaken to generate a list of generic maintenance tasks. This was accomplished by developing a list of behaviors or task actions based on the components and modules previously identified. These behaviors,

which included such terms as "align" or "operate," were coupled with the six generic components to provide a generic task such as "align power supply" or "operate receiver." The generic tasks were then reviewed by ET and EW school personnel to verify that they were performed by the two groups of technicians. The terms "fault isolate" and "troubleshoot," perhaps the most important behavior taught in the "A" schools, were not included in the generic task listings. Since these terms were considered to represent logical sequences of tasks (procedures) that are contingent upon specific faults and fault symptoms, equipment configurations, and the outcome of individual test and measurement activities, they were excluded in all cases except where more descriptive task terminology could be applied. Thus, a general outline of the components and modules to be simulated and tasks to be performed (except for fault isolation and troubleshooting) was developed. The incorporation of procedural tasks remained to be completed as more definitive generic equipment design data became available.

Training requirements defined for EEMT were based on the task and equipment commonality analysis. Essentially, the training requirements analysis was a systematic presentation of the tasks outline translated into lesson objectives and organized according to the component involved. A total of 40 major enabling objectives based on 43 common maintenance tasks were identified. The synthesis of lesson objectives from the common tasks yielded a preliminary "common-core" syllabus that was intended to be incorporated as a single segment of instruction within the ET and EW "A" school curricula. The most appropriate location of the segment was determined to be between the fundamentals and equipment-specific phases of each curriculum (Koch, Daniels, Pine, Herringa, Josefowitz, Persons, Albing, & Carleton, 1979).

Master teachware algorithms were also produced to guide and standardize the development of EEMT lessonware. These were intended to be general guidelines for the formulation of procedures necessary to a particular common task action or generic objective.

EEMT Hardware Design

Initial design goals for the EEMT system included a reduction of 50 percent or more in the need to use operational prime equipment in the target schools and a 10 percent or greater improvement in training efficiency/effectiveness. To accomplish these goals, the hardware system must be capable of supporting both generic systems and representative of actual equipment training. The selected hardware approach has been to incorporate a separate two-dimensional (2D) and three-dimensional (3D) component design concept. Each system component is capable of implementing a different level of simulation fidelity. The 2D unit shown in Figure 1 is a general-purpose, low-fidelity trainer/simulator designed to support concept and procedures learning and general electronic system troubleshooting tasks. The 3D unit, shown in Figure 2, is intended to provide "hands-on" experience in a variety of generic troubleshooting, test and alignment, and repair tasks associated with different families of electronic equipment. The equipment families currently being represented correspond to electronic systems being taught in the target schools and include radar, communications, and electronic countermeasures (ECM)/electronic support measures (ESM) systems.

<u>2D Unit</u>. Functionally, the 2D trainer/simulator is capable of displaying, on a flat screen (CRT), all components and conditions required to operate and troubleshoot the system being simulated. Displayed images are hierarchically organized and include system and equipment images at the higher levels and all controls, indicators, and test points at the lower levels. Simulated equipment manipulations and other interactions are

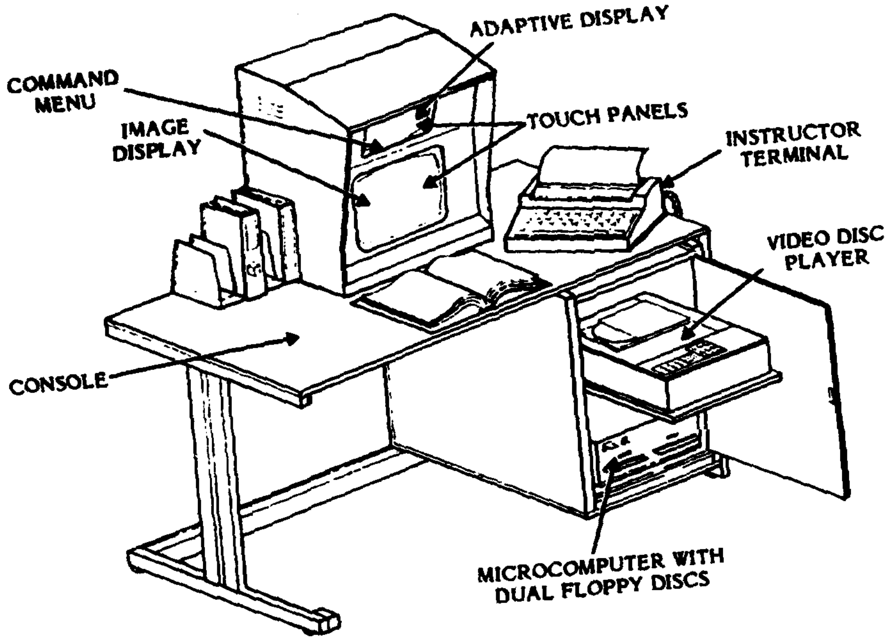


Figure 1. 2D EEMT.

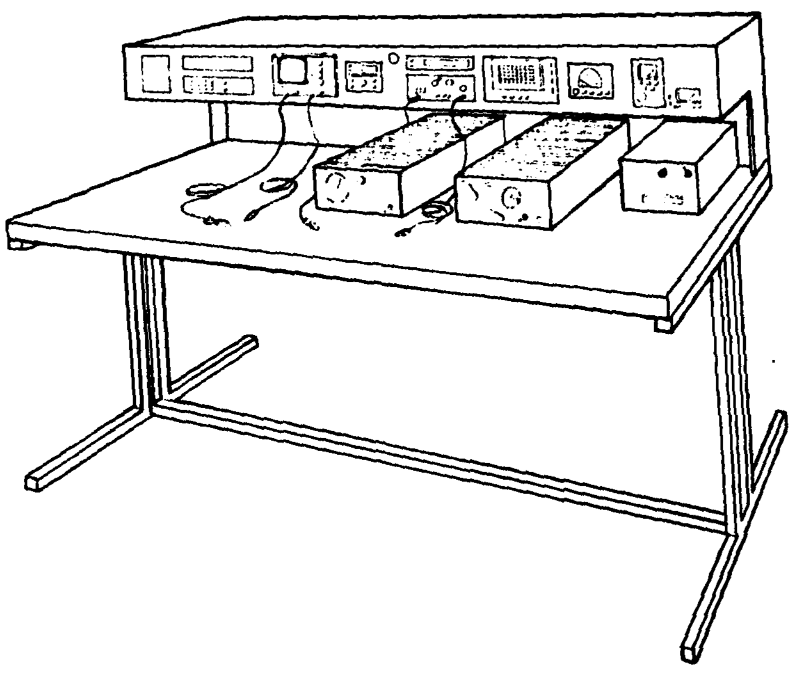


Figure 2. 3D EEMT.

made through electrically-conductive touch panels covering the two CRT displays. The trainer also allows access to similar displays of test equipment and test equipment readings. Test equipment readings are matched to expected values for the simulated equipment during normal operations and during fault conditions that are defined in the EEMT system problem repertorie. The sum of all stored images and equipment conditions for a given electronic system constitutes an EEMT simulation data base.

The 2D unit is also capable of displaying general text, including expository lesson materials, help and prompting messages, and other information required to guide a student through lesson steps or procedural exercises. The software system provides for interpreting student actions, selecting the next appropriate image and/or text display, and tracking and recording student performance.

3D Unit. The 3D unit, the hands-on component of the training system, is connected to, and controlled by, the 2D unit computer. The 3D unit hardware consists of a permanently-mounted suite of simulated electronic test equipment and a series of plug-in equipment drawers. The equipment drawers employ a generic system design concept and are constructed as functional representations of the three electronic equipment families included for EEMT system T&E. Figure 3 is a conceptual drawing of one of the generic equipment drawers. As shown, the drawer is built on staging concepts in which each stage is an identifiable functional element of the system being represented. Individual stages are replaceable to allow for simulating various levels of electronic technology ranging from vacuum-tube to large-scale-integration (LSI) circuitry. Test equipment front panels are simulated with high fidelity. Detachable probes and lead wires are provided for connecting various jacks and test points within the equipment drawers. The 3D unit uses low-voltage computer-generated signals and presents no electrical hazard to the trainee. All system outputs are derived digitally and reside in the trainer program simulating data base.

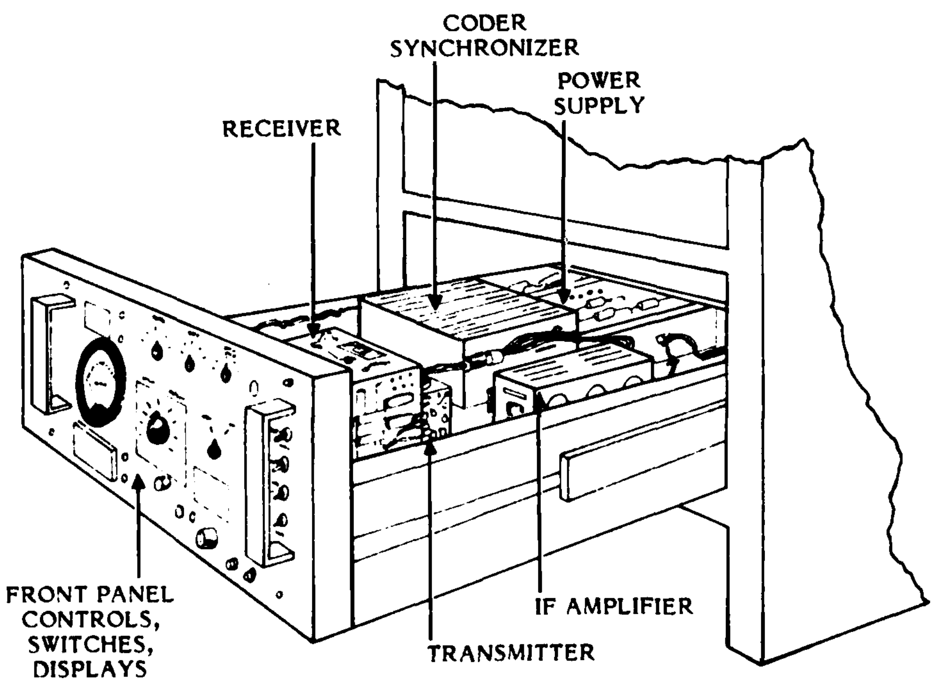


Figure 3. EEMT system example of functional equipment module.

Revised EEMT Curriculum Design Requirements

Upon commencing Phase III prototype development, it became apparent that the preliminary EEMT syllabus and objectives were not totally consistent or compatible with the hardware design and simulation approach selected for system implementation. Detailed teachware algorithms were required for individual EEMT objectives that would specify simulation data base content and that would assist in tailoring each objective to the type of equipment or component being addressed. To incorporate EEMT lessons into the existing ET and EW "A" school curricula effectively, the following constraints also had to be considered:

1. The EEMT objectives must match topics and objectives in the "A" school curricula.

2. The hours of EEMT instruction must be consistent with current "A" school time allotments.

3. To avoid confounding the T&E, no new objectives, procedures, or information should be introduced into the EEMT lessons.

4. System familiarization objectives must be included to preserve the "top-down" training approach.

5. Specific system and component troubleshooting objectives must be included in the EEMT lessons.

6. Procedures and task actions must transfer to actual equipment.

EEMT T&E Curriculum Components

The EEMT is being designed to support both generic and representative equipment training in the target schools. The generic approach is intended to help bridge the gap between the fundamental, theory-oriented parts of the "A" school curriculum and the specific equipment training that follows. Figure 4 illustrates the hardware relationship between the EEMT and three electronic equipment families for which simulation data bases and instructional support modules are to be developed. The three equipment families include radar, communications, and electronic warfare countermeasures/support measures systems. Three specific equipment simulation data bases and instructional support modules are also to be made available for EEMT system T&E. These training support packages are intended to assist in measuring the effectiveness of generic systems training and the transfer of training to actual equipment in the schools' hardware laboratories. The three specific equipment systems include the AN/SPS-10 radar set, the AN/WSC-3 satellite communications set, and the AN/SLQ-32 electronic warfare support measures system.

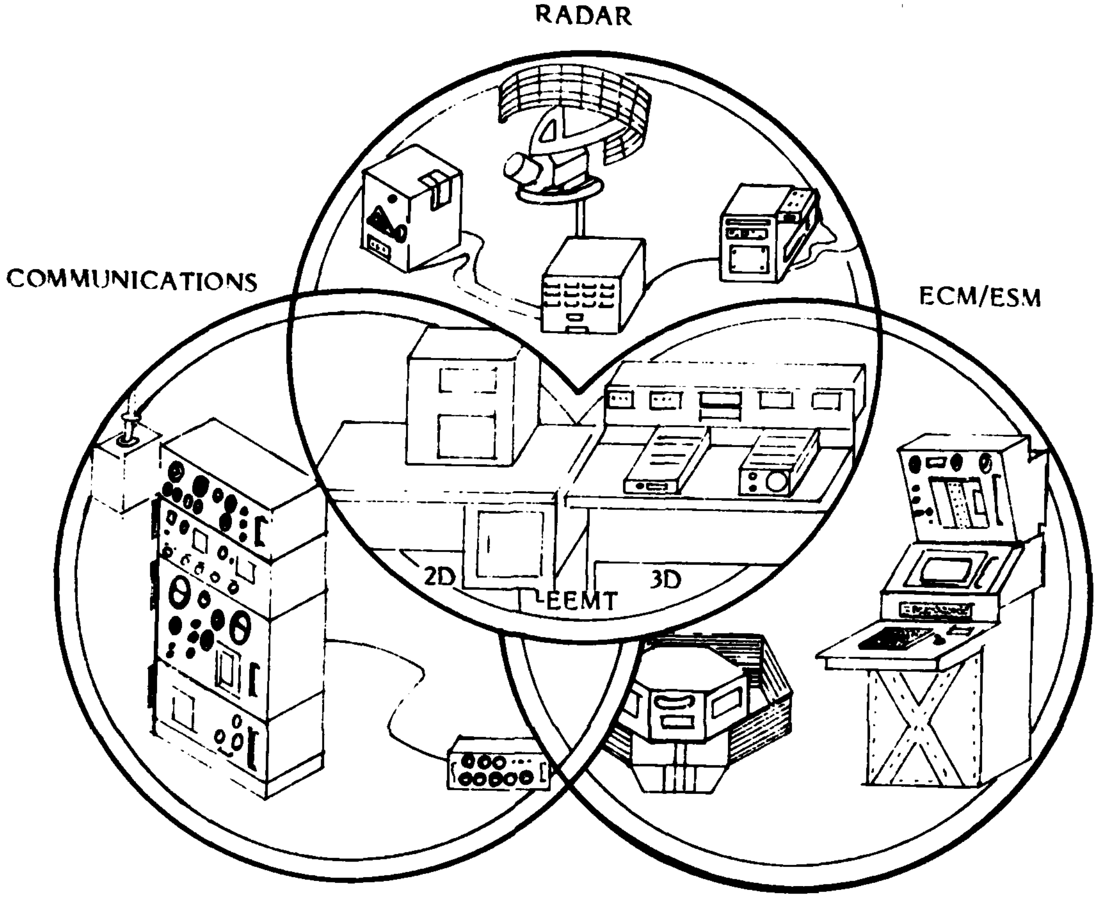


Figure 4. EEMT as a generic simulator for three families of equipment.

The EEMT generic system concept is intended to condense the subject matter of electronics maintenance training to its common components and emphasize the similarities in signal processing functions found to exist within the three target equipment families. The training objectives in the generic syllabus therefore focus on functional tests and measurements, alignments, and the general logic of troubleshooting. A summary of the training objectives intended to be met in the generic syllabus for EEMT T&E is provided below:

1. Individualized instruction and guided practice in the functional organization of individual families of naval electronic equipment and systems.

2. Instruction in the purpose and operation of functional units, sections, groups, circuits, or other functional elements, as appropriate to each equipment family.

3. Instruction and practice in logical troubleshooting including the following specific task areas:

a. Observation/isolation of symptom set.

b. Formulation of hypotheses, including interpretation of functional states, location of test points, performance of test and measurements, and use of test equipment.

c. Verification of hypotheses or formulation of new hypotheses.

d. Performance of in-place adaptive corrections.

e. Verification of proper equipment operation.

f. Completion of maintenance documentation.

4. Instruction and practice in performing operational checks and adjustments, including alignment and calibration actions appropriate to the equipment family at issue.

5. Instruction and practice in the use of maintenance manuals and diagrams.

6. Instruction and practice in preventive maintenance procedures.

Objectives to be met in the represenitive equipment syllabi parallel those listed for the generic systems. In many instances, they are identical in terms of specific equipment components. For generic systems curriculum development purposes, it was necessary to incorporate several functional adaptations of various hardware components within the designated equipment families. These components were matched with generic task data to assist in generating preliminary functional hardware designs for the 3D generic system and in turn used as tentative objectives for representative equipment T&E syllabi. Representative equipment objectives will be limited to the 2D simulation only.

Functions to be Simulated

The primary function of the EEMT hardware is to simulate components and conditions required to operate, align, and troubleshoot the included systems. Specifically, the 2D unit will be required to display visuals of equipment controls and indicators, equipment block diagrams, and layouts. For concept and procedure lessons, it must also display generality steps and amplifying data to guide learning and practice. It must present performance-related questions and provide feedback on the accuracy of student responses. If the feedback is negative, it must provide reasoning for the correct response.

The 2D unit must also simulate aspects of a digital multimeter, oscilloscope, or other relevant test equipment in order to access test points on equipment simulations or block diagrams. Displayed voltages, wave forms, frequencies, phase relationships, etc. at available test points must match expected values for the equipment during normal operations and during the fault conditions defined in the EEMT system problem bank. Prompt and help messages must be available to assist the student in interpreting system responses. Details for each training exercise must be appropriately defined and ordered in the training/simulation data base.

The 3D unit must also provide for using test equipment both with the systems being simulated and in conjunction with other test equipment (e.g., oscilloscope used to measure

output of a signal generator). It must provide a means for connecting test leads in the same manner as performed on actual equipment. This capability must provide a high level of task fidelity during system testing and fault isolation. The communications system module must provide functional simulation in the frequency range of 2 to 30MHZ for steps required in operating, testing, aligning, and fault isolating components of the system during all modes of operation. Signal simulations will be required at all test points during amplitude modulation (AM), continuous wave (CW), frequency shift keying (FSK), or single-sideband (SSB) modes of operation. The controls and indicators for the communications system must provide proper indications and conditions for each phase of an exercise and for each component. It must provide simulation for high-voltage power supply functional checks, operation, and fault isolation. As presently conceived, the radar simulation will represent mostly vacuum-tube technology while the communications system will represent transistor technology. The electronic surveillance measures (ESM) system module must provide a functionally operational system that will, in the appropriate frequency ranges, simulate all steps and conditions required to perform operational checks, system alignment, and testing of power supply components. The ESM system module must represent integrated circuit technology and provide for a wide range of equipment diagnostic testing. The 3D unit must be capable of interacting with the 2D unit so that displays of appropriate generality and help routines required for the system under test can be accessed.

APPROACH

The approach for developing EEMT T&E curriculum outlines consisted of four tasks, which are listed below and described in the following sections. The first two tasks are described within the context of a methodology called estimate-talk-estimate.

1. Analyzing existing documentation.
2. Interviewing Navy personnel.
3. Formulating generic and representative equipment syllabi.
4. Developing lesson specifications.

Estimate-Talk-Estimate

Estimate-talk-estimate (E-T-E) is a method to structure group discussions for decision-making purposes (Armstrong, 1978). Like the Delphi technique, E-T-E is a set of procedures for eliciting and refining the opinions of a panel of experts to obtain a consensus of opinion on the topics under consideration. It is similar to the Delphi technique in that (1) anonymity of responses is emphasized, (2) the respondents are experts, (3) more than one round is required to obtain consensus for making decisions, and (4) controlled feedback from previous rounds is provided. However, the E-T-E procedures call for face-to-face group discussions in the talk round rather than mailed questionnaires. The primary advantages of the E-T-E method over Delphi designs are (1) the speed of responses due to the face-to-face discussions, and (2) a practical rather than statistical definition of consensus related to the discussion can be made. Two separate E-T-E rounds were conducted to satisfy the requirements for both the generic systems and representative equipment syllabus.

First-estimate Round

The intent of the first-estimate round was to develop tentative syllabi and questionnaires to be used in the talk round. The tentative syllabi were developed as a "strawman" to identify objectives in the ET and EW "A" school curricula that were

consistent with project goals and that could also be trained on the EEMT. The questionnaire was to be used as a tool to review and critique the content of the tentative syllabus on a systematic basis.

Several activities were required to develop the tentative syllabus and questionnaires. First, existing documentation was analyzed to determine the criteria for selecting objectives to be trained on EEMT. This analysis included a review of relevant Navy documentation, such as ET and EW "A" school curricula publications, the operational requirement for Class "A" EEMT system (OR PN-50) (Chief of Naval Operations, 1976), the detailed characteristics for EEMT systems (McMichael, 1979), the preliminary EEMT device test and evaluation master plan (Pine, Daniels, & Malec, 1981), and the training requirements and analysis data generated during the project system definition phase. Technical manuals for representative equipment and a draft user's guide for the 2D unit (Lahey & Malec, 1982) were also reviewed.

Followng the documentation review, a tentative listing of behavioral objectives was prepared. System T&E objectives were chosen partly based on the following criteria:

1. Present a "top-down" approach to equipment familiarization.

2. Guide the student through a variety of maintenance tasks.

3. Involve equipment and tasks compatible with EEMT's 2D/3D mode of simulation for generic systems objectives and 2D mode only for representative systems objectives.

4. Incorporate behavoral tasks that appear to be common to both ET and EW ratings.

5. Involve electronic components common to the ET and EW schools.

6. Involve the use of test equipment for the majority of equipment maintenance tasks.

7. Represent difficult, dangerous, or hard-to-simulate tasks, equipment, or environments.

Also, preliminary telephone contact was made with Navy personnel to assist in identifyng relevant objectives.

A second step in the first-estimate round was to review the training approaches used in the two schools to teach electronics and electronic equipment maintenance. An analysis of ET and EW school prime equipment inventories was conducted to assist in verifying common objectives in terms of equipment technology, maintenance procedures, and test equipment used to support training. Several significant differences were found between the two schools in both the numbers and types of equipment being used. Since these differences contributed to substantive curriculum differences in topic areas conceptually shared by the two schools, it was decided to prepare separate ET and EW syllabi for use in the talk round. A more detailed discussion of the equipment differences and the effects on the T&E syllabus development is provided in the discussion section of this report. Objectives included in each tentative syllabus were subsequently written to meet the form and substance of existing curriculm objectives, placed within similar topic areas, and cross-referenced to the existing curricula by objective numbers. Both syllabi were organized into four units--system familiarization, equipment maintenance tasks,

component maintenance tasks, and module maintenance tasks--to provide a "top-down" approach to training. Each EEMT objective in the syllabi was tentatively identified as a 2D or 3D applications objective. The number of classroom and laboratory hours currently allocated to the ET or EW objectives was also provided where possible to assist in estimating the length of the EEMT lessons.

For purposes of questionnaire development, objectives selection criteria were organized into two categories--equipment-related issues and training-improvement issues--and stated in question form. Questions concerning equipment-related issues were designed to (1) solicit information concerning the generalizabiity of included tasks, skill, and knowledge objectives to a larger population of equipment maintained by the ET and EW ratings, (2) seek opinions as to whether certain objectives could improve the transition from electronics fundamentals to equipment-specific training while also minimizing the dependence on operational prime equipment, and (3) identify objectives that can be applied to differing technologies (vacuum-tube modularized discrete components, modularized integrated circuits, and modularized monolithics) found in the equipment maintained by the two ratings. Questions concerning training improvement issues focused primarily on the identification of topic areas or objectives that (1) consistently require remediation, contribute to academic setback, or in other ways result in student proficiency problems, and (2), under EEMT use, could result in reduced training time or improved student performance. Several additional training-improvement-related questions were included to solicit information concerning the relationship of certain objectives to possible training management problems, such as those that strain instructor resources and that might contribute to a bottleneck in the training flow. The questionnaire used during the talk round in conjunction with the tentative generic and representative equipment syllabi is provided as Appendix A.

Talk Rounds

Several activities were conducted during the talk rounds. These involved identifyng a panel of Navy experts, scheduling and conducting face-to-face discussions with the designated experts, and making preliminary revisions to the tentative syllabi based on the results of the discussions.

One aspect of selecting the panel of experts was to ensure that all interested and involved Navy activities were represented. The expert panel was constituted as follows:

1. ET and EW school management personnel, training officers, division officers, division heads, educational specialists, and course instructors.

2. Curriculum developers from the Instructional Program Development Center (IPDC) detached to the Service School Command at Great Lakes, Illinois and the Consolidated Navy Electronic Warfare School at Corry Station, Pensacola, Florida.

3. "A" school training program coordinators (TPCs) from the Chief of Naval Technical Training (CNTT), Millington, Tennessee.

4. Research personnel from the Training Analysis and Evaluation Group (TAEG), Orlando, Florida.

5. The EEMT program manager from the Navy Personnel Research and Development Center (NAVPERSRANDCEN), San Diego, California.

Three face-to-face discussions were conducted during the talk round for the generic systems syllabi (one at TAEG, one at the ET school, and one at the EW school) and two at each "A" school for the representative equipment syllabi. Since TAEG personnel were initially involved with the development of the draft EEMT T&E master plan and will ultimately be responsible for conducting the T&E effort, their input concerning various practical considerations associated with selecting testbed EEMT instructional modules was obtained. Additional information concerning the generalizability of objectives transfer of training, and the incorporation of various instructional strategies was also obtained for general use in developing the final EEMT curriculum outlines.

School management, instructional staff, and TCP and IPDC personnel attended meetings at each school. Using the questionnaire as a starting point, the tentative syllabi were reviewed for organization and content. The EEMT objectives were matched to objectives in the existing curriculum to evaluate content and suitability for testbed instruction. Placement of EEMT testbed lessons into the existing pipeline was also discussed. School constraints and concerns were identified. Preliminary revisions, such as adding and deleting objectives, changing time allocations, and describing functions and applications in more detail were made during these meetings. The result of the talk rounds was a general consensus relating to specific objectives to be included in the final syllabi and a reasonably clear understanding of perceived organizational needs and constraints.

Final-estimate Rounds

The final estimate rounds consisted of reorganizing and refining individual generic system and representative equipment syllabi. Follow-on telephone conversations with panel members were conducted as required. Technical documentation in the form of maintenance requirement cards (MRCs), technical manuals, jobsheets, and instructor and student guides corresponding to selected objectives were identified. The documents were used to refine individual curriculum outlines further and were used later in the preparation of lesson specifications. Draft final syllabi were forwarded to panel members for comment and approval.

Formulating Generic and Representative Equipment Syllabi

An intermediate step in T&E syllabus development was to prepare a conceptual system model for each of the three generic equipment families included in the design effort. The conceptual models had to include all controls, indicators, test points, and functional components required to perform T&E curriculum objectives. Functional adaptations of various components in the prime equipment family were used as being representative of that family and assisted in providing the necessary clarity and procedural detail required for developing first draft lesson specification. The general system characteristics incorporated in the conceptual models are described below.

Figures 5 through 7 show the controls and indicators used to represent the generic communications, radar, and electronic warfare systems. They also illustrate an assumed internal equipment-staging configuration in block form. Table 1 lists the components containing the functional equipment adaptations selected for use in the generic systems and the functions to be simulated.

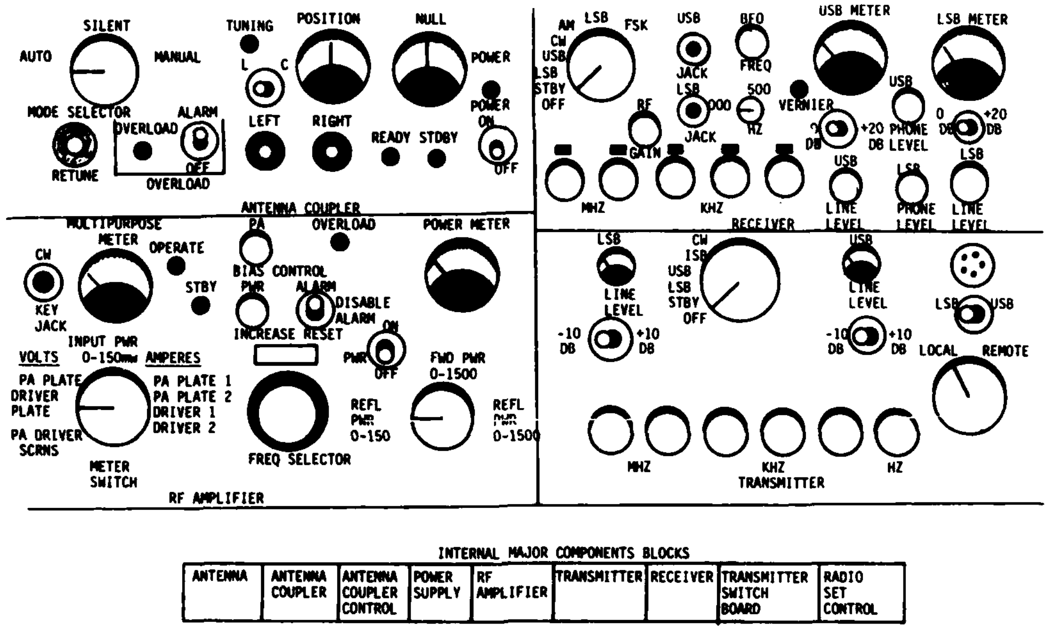


Figure 5. EEMT system communications front panel.

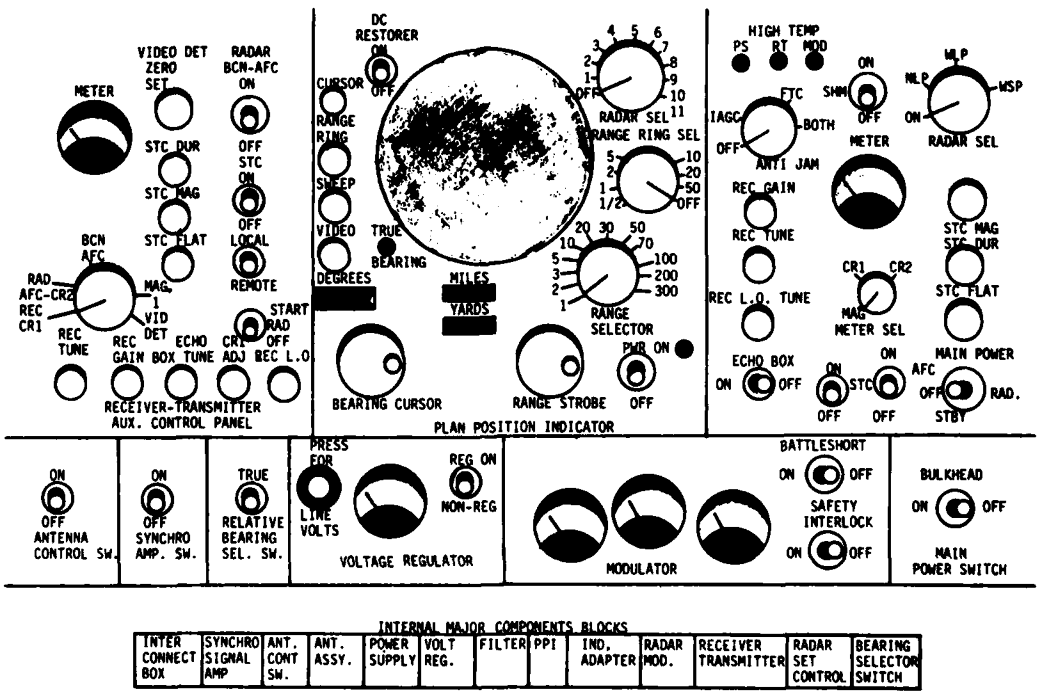


Figure 6. EEMT system radar front panel.

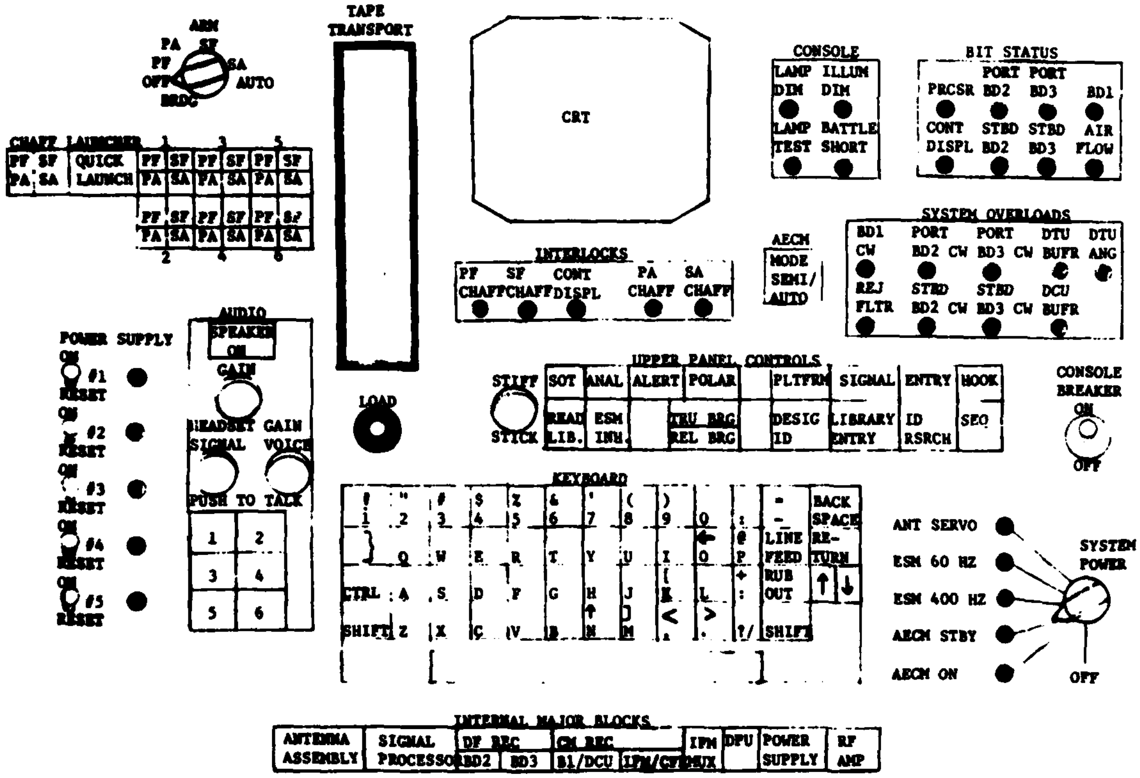


Figure 7. EEMT system ESM front panel.

Table 1

Functions Simulated for Generic Systems

Components Containing Functional Equipment Adaptations	Functions Simulated
Communications System	
Transmitter T-82 Receiver R-1051 Antenna coupler CU-938/URA-38 Antenna coupler C-3698/URA-38 Power supply PP-3916 RF amplifier AM-6909 Radio set control C-1138 Transmitter switchboard SB-83 Antenna (simulated)	Operation of the transmitter in ISB, LSB, USB, AM, CW, standby, and FSK modes. Adjusting the PA bias on the transmitter. Adjusting the PS driver screen voltage on the transmitter. Adjusting the PA driver plate voltage on the transmitter. Adjusting the PA plate voltage on the transmitter. Tuning the transmitter antenna system. Aligning the transmitter. Fault isolation to modules in the transmitter. Operation of the receiver in ISB, LSB, USB, AM, CW, standby, and FSK modes. Measuring the receiving sensitivity. Aligning the receiver. Fault isolation to modules in the receiver.
Radar System	
Radar set control C-1134A/SPS-10[a] Receiver-transmitter RT-272A/SPS-10 Radar modulation MD-176A/SPS-10 Indicator adapter MX-1399A/SPS-10 Plan position indicator AN/SPA-25 Band suppression filter F-188A/SPS-10 Voltage regulator type CCJE-30AAP-1 Power supply PP-866A Antenna assembly AS-936A/SPS-10 Manual controller switch S1501 Antenna control switch S1401 Synchro signal amplifier MK2-MOD2A Bearing selector switch S1001 Interconnecting box J-510B/SPS-10	Operation of the radar system to display data on the plan position. Operation of the radar system controls to perform receiver turning checks. Measuring the receiver minimum discernible signal. Aligning the radar system. Fault isolation of modules in the receiver-transmitter. Performing power supply voltage measurements. Performing adjustments of the radar power supply. Fault isolation of modules in the power supply.
ECM/ESM Systems	
Antenna assembly AS-3317/AS-3318/AS-3316 CM receivers CMR-2122/CMR-2123 DF receivers R-2120/R-2121 Signal processors CP-3170/CP-3171 Electronic frequency converter/multiplex unit Computer and interface unit CP-1374 Power supply (Unit 3) Semi-omni amplifiers AM-6999	Performing the ESM system diagnostic tests. Measuring the multibeam/IFM sensitivity of the ESM system. Measuring the sensitivity and frequency accuracy of the band 1 receiver. Measuring and adjusting the receiver noise level for channels A and B. Performing ESM correlation timing adjustments. Performing false alarm rate adjustments.

[a]Although the AN/SPS-10 radar set uses vacuum-tube technology throughout, the EEMT radar simulator can use state-of-the-art technology for all areas except the AC voltage regulator, power supply, receiver-transmitter, and modulator, which will be incorporated in the T&E curriculum to fault-isolate vacuum-tube technology.

The following test equipments were selected for use in both 2D and 3D simulations:

1. Oscilloscope AN/USM-425.
2. RF signal generator SD-1626 and HP-606B.
3. Universal counter H-5328B.
4. Digital voltmeter HP-3028 or John Fluke 8000A.
5. Spectrum analyzer Tektronic model 492 and TS-1329.
6. Multimeter AN/USM-116.
7. Power meter model 476 general microwave.

The simulated test equipment functions will require use of the following equipment and accessories: logic probe, attenuators, voltage dividers, attenuator probes, 10:1 and 1:1 probes, and dummy loads.

Developing Lesson Specifications

Once the objectives were organized into EEMT lessons in the ET and EW "A" school syllabi, lesson specifications were developed. The lesson specifications include:

1. Statement of the objective.

2. The selected media for presentation of the objective (2D or 3D simulation).

3. The objective classification according to instructional quality inventory (IQI) specifications (Ellis & Wulfeck, 1979).

4. A statement of the generality listing the steps of instruction.

5. An algorithm amplifying and sequencing generality steps.

6. A list of the supporting graphics.

7. Instance specifications describing student performance evaluation criteria.

The format for the lesson specifications was based on the prescribed MIL-T-29053, Training Requirements for Aviation Weapons Systems, except for the addition of the algorithms. These algorithms were included to provide precise guidelines for implementation of EEMT lessonware on the 2D and 3D units. The specifications were designed to supplement the EEMT Data Base User's Guide (Lahey & Malec, 1982), which includes guidelines for preparing system image hierarchies and related hardware requirements for constructing a simulation data base.

Individual worksheets were prepared for each objective based on its IQI classification. For example, lessons that focused on concepts required information consisting of the concept name or nomenclature and the critical characteristics of the concept. Procedure objectives require that the steps of a procedure be listed as well as the expected outcome for each step (e.g., system indications, meter readings, etc.). Procedure objectives were located in the syllabi after concept-oriented objectives. Rule objectives such as fault isolation require identification of the faulty module or part and the symptoms or effects on the system for that fault. These objectives were located in the syllabi after procedure objectives. Figures 8 and 9 illustrate the instructional flow for concept and procedures lessons respectively.

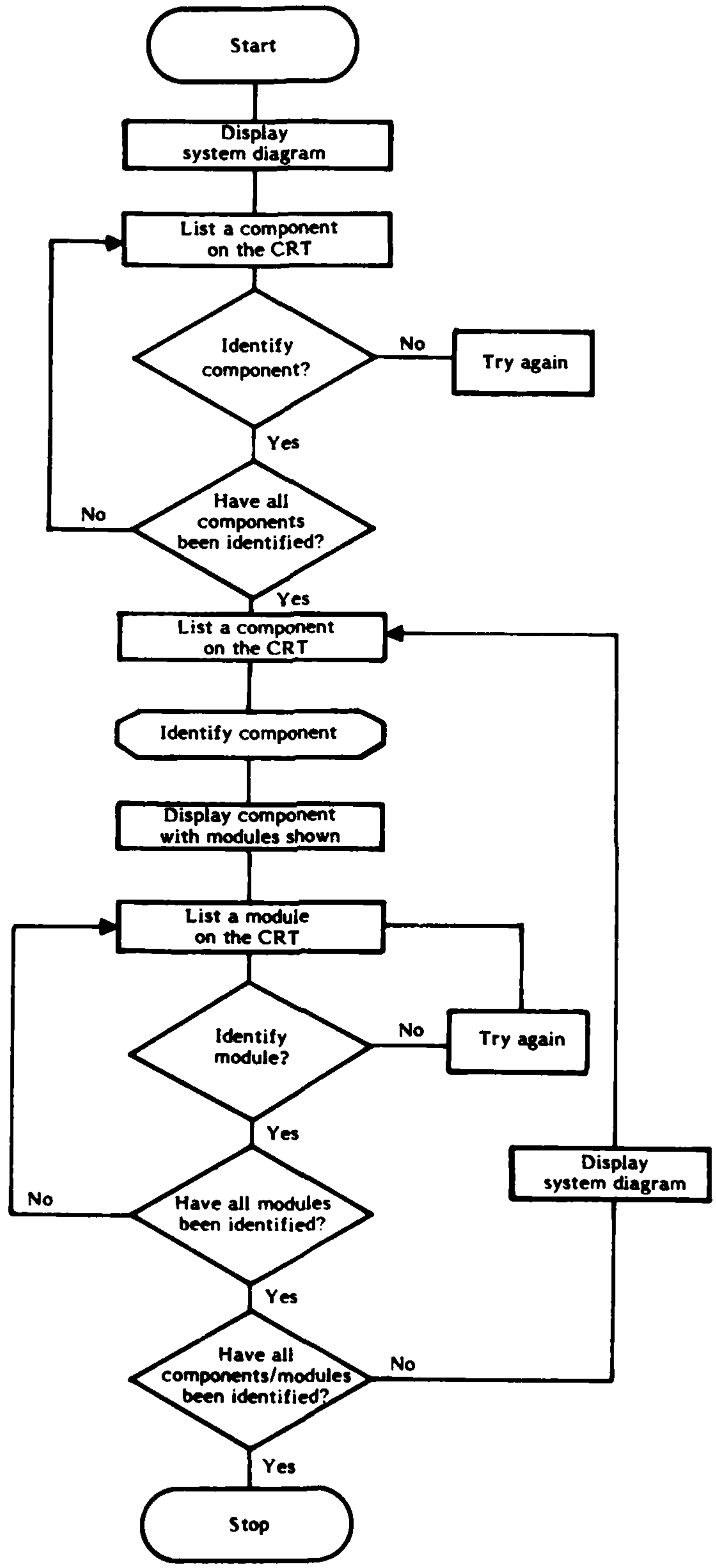


Figure 8. Lesson flow concept objectives.

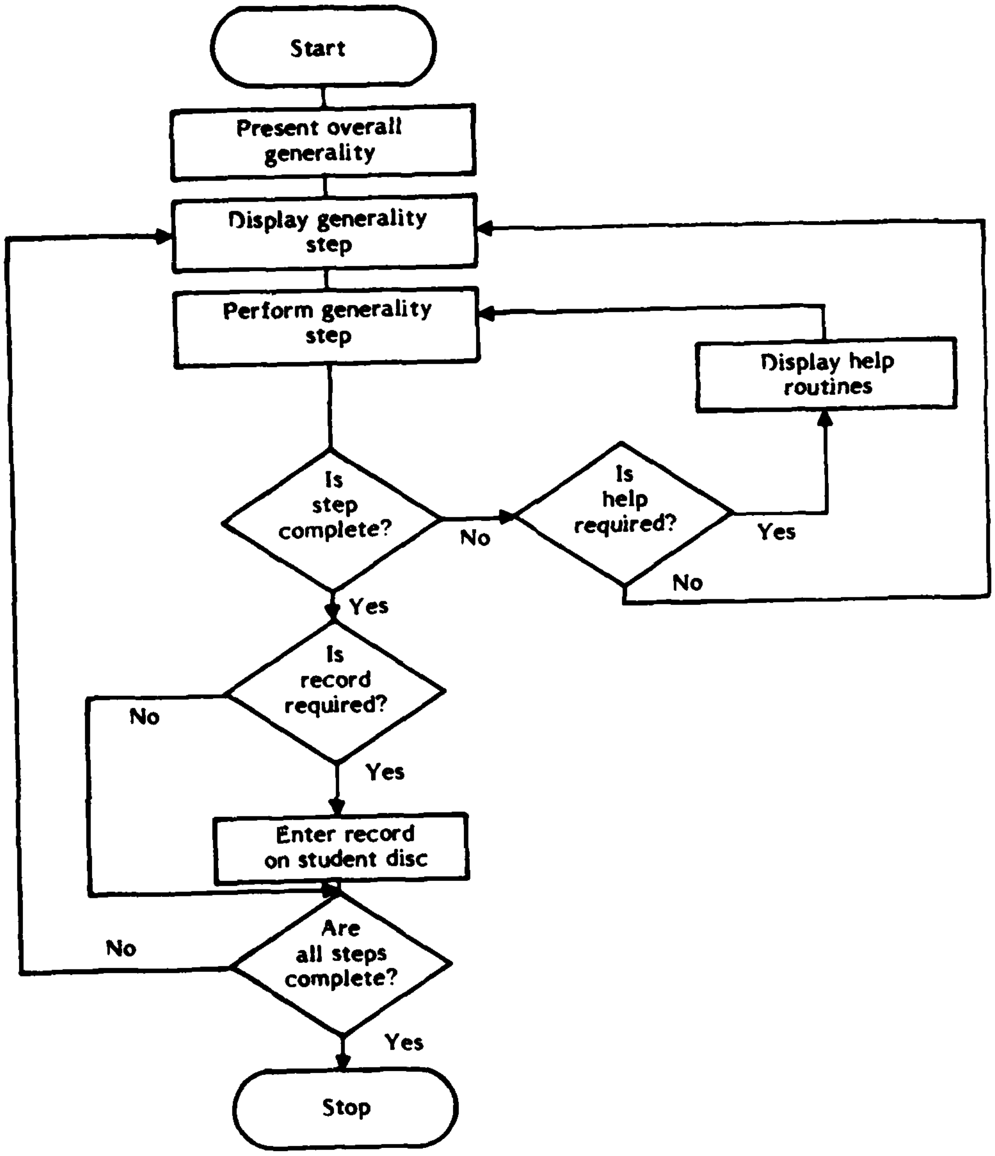


Figure 9. Lesson flow procedure objectives.

Fault isolation lesson specifications were organized using the instructional flow depicted in Figure 10. This sequence follows the generalities provided for each troubleshooting objective and proceeds from a general description of the fault symptoms, to isolation of the fault symptoms, to isolation of the faulty module, circuit, or component. A failure analyses is included to ensure that all faults have been identified and corrected. The information from the worksheets was then transcribed into the lesson specification format described and submitted to expert panel members for review. The key aspects of the lesson specifications are described in the following subsections.

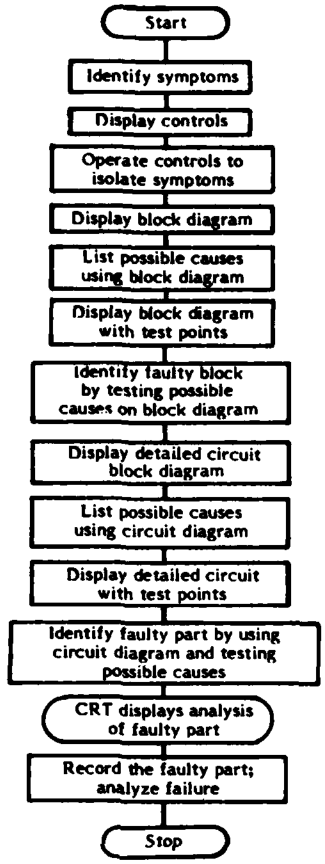


Figure 10. Lesson flow fault isolation objectives.

Media Selection

For the generic syllabi, the EEMT mode of presentation, 2D or 3D, was determined by the characteristics of the tasks identified in the objectives and an estimate of a reasonable distribution of tasks between the two units. Most knowledge and simple motor skill-oriented objectives were assigned to 2D while the greater portion of performance-oriented tasks (i.e., preventive maintenance, corrective maintenance, align/adjust) were assigned to 3D. Test equipment operations will be presented on both 2D and 3D units. The actual connection of test probes and dynamic testing will be done on 3D only. Tutorial instructional material for representative system objectives will be presented on 2D only.

Generality

The generality consists of steps of the maintenance, operation, or fault isolation procedures, or statements of the facts and concepts to be learned. The generalities, which represent the skills and/or knowledge that the student must learn and perform to attain the lesson segment objective, were derived from MRCs, jobsheets, instructor and student guides, and techical manuals.

Algorithm/Graphics

Maintenance instruction algorithms (MIAs) were developed to identify and integrate generality steps, required graphic displays, trouble symptoms, and decision points occurring within a particular lesson segment. The MIAs, which are intended for use by lesson developers in the production of actual lesson materials, provide a definite structure for lessons being presented on the 2D and 3D units and assist in identifying required graphics, procedural prompts, helps, and other incorporated instructional strategies. Specific MIAs corresponding to the intended instructional flow for the three types of objectives included in the EEMT T&E syllabi are presented in Figures 11, 12, and 13. Each MIA is constructed to identify student and machine actions, required cues, prompts and tutorials, and lesson segment evaluation strategies consistent with EEMT methods of presentation. Presentational methods are, of course, based on the projected EEMT system capabilities described earlier.

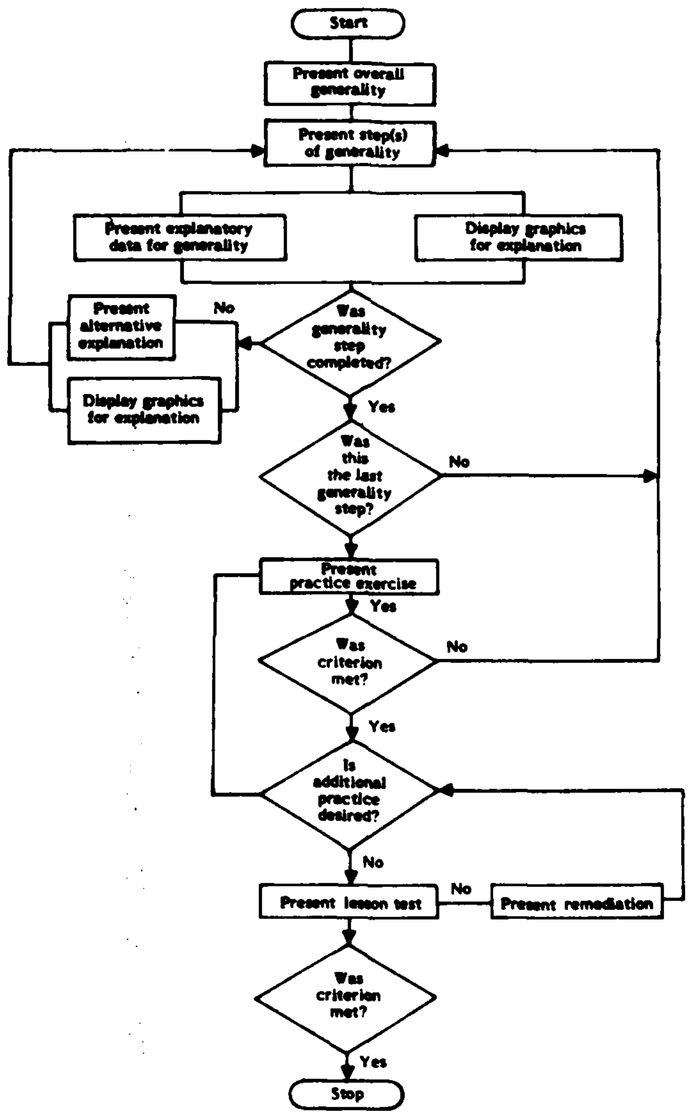


Figure 11. Lesson segment presentation concept objectives.

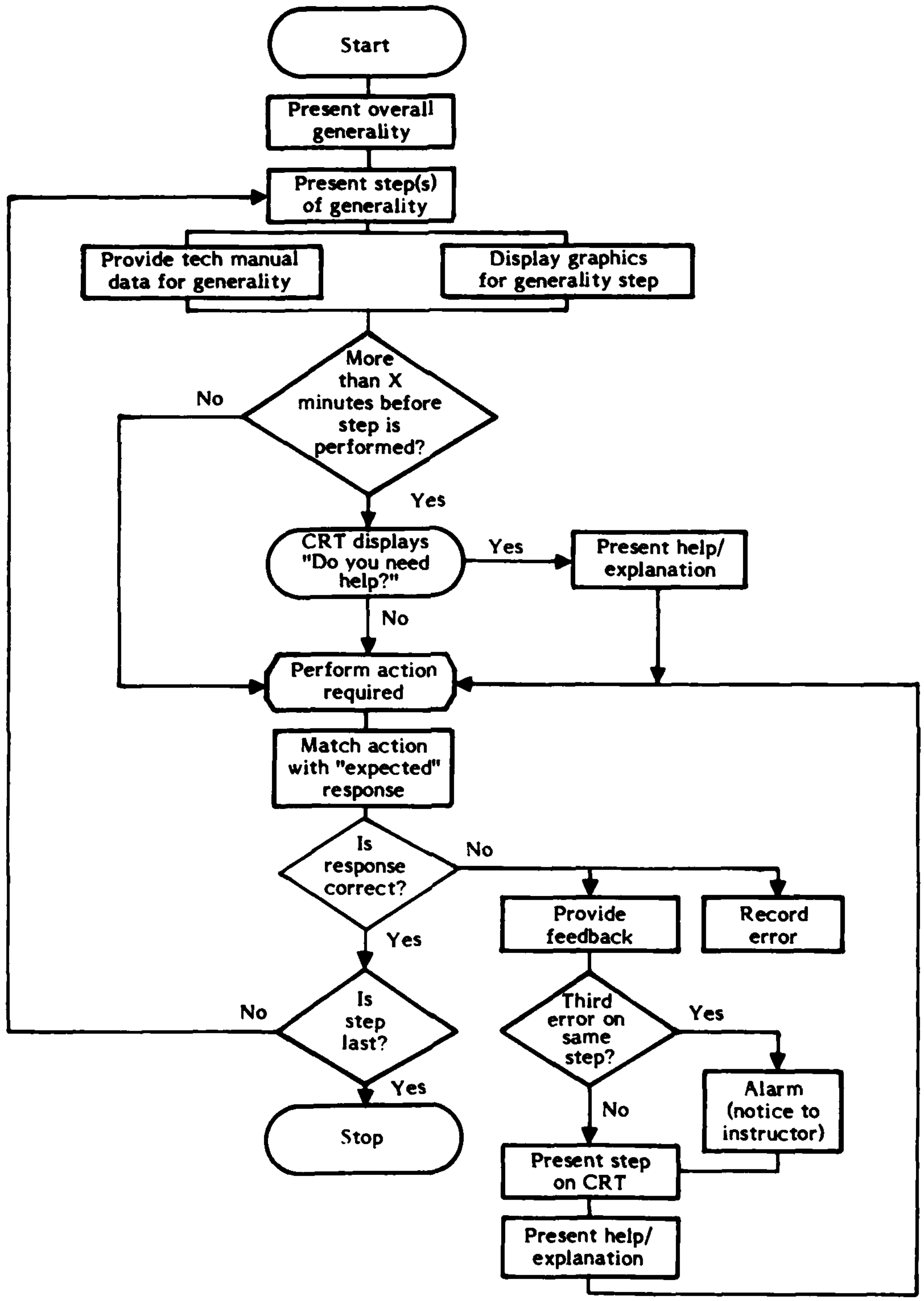


Figure 12. Lesson segment presentation procedure objectives.

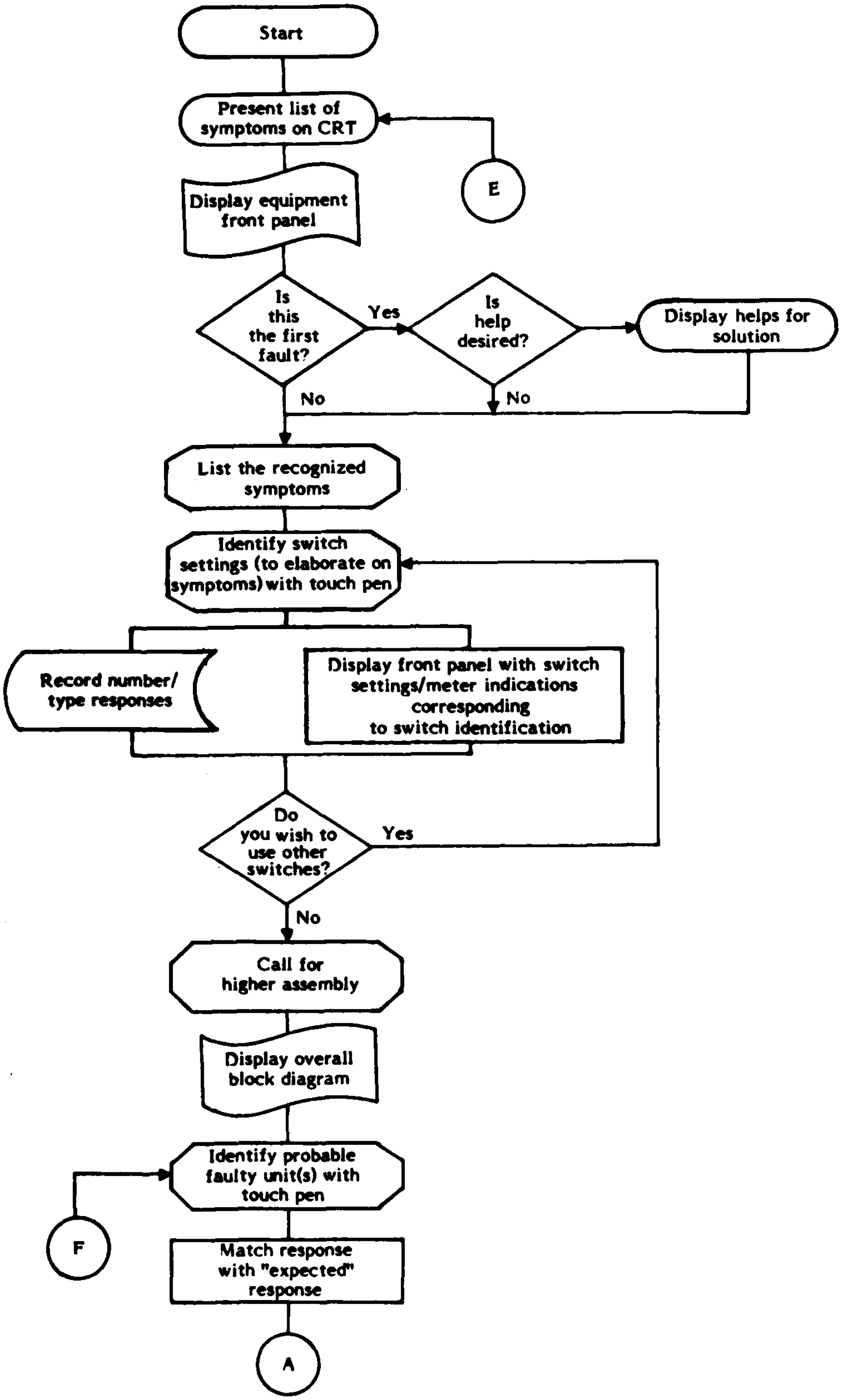


Figure 13. Lesson segment presentation fault isolation objectives.

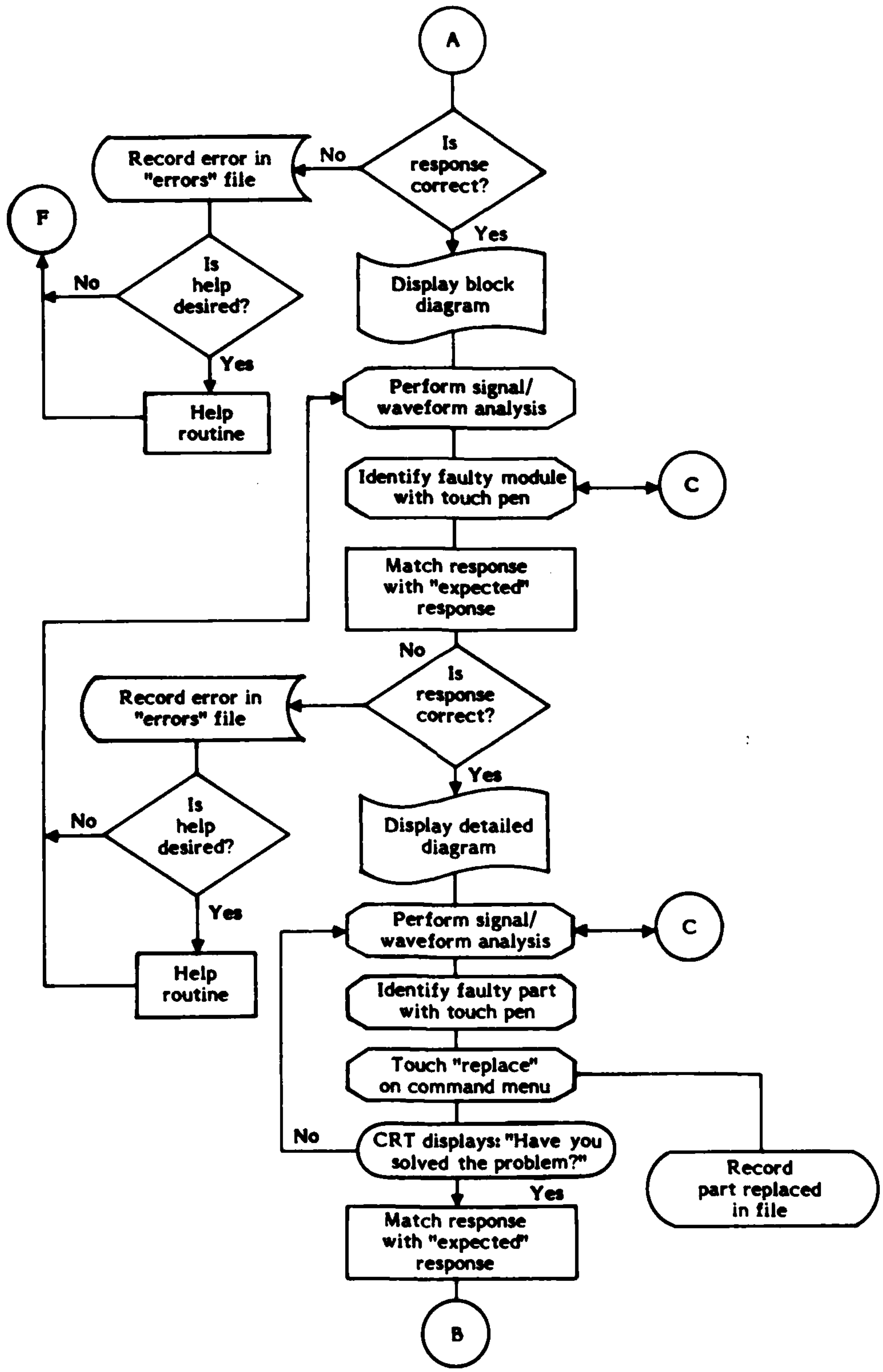
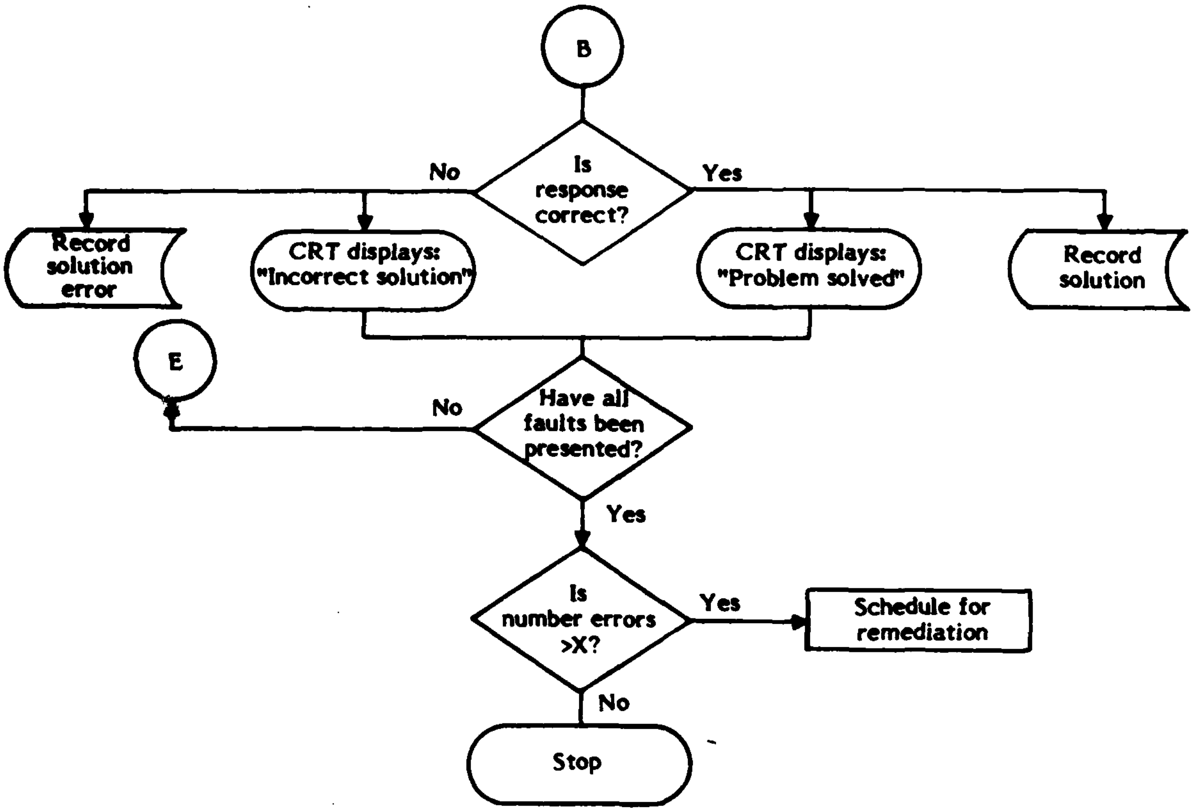


Figure 13. (Continued.)



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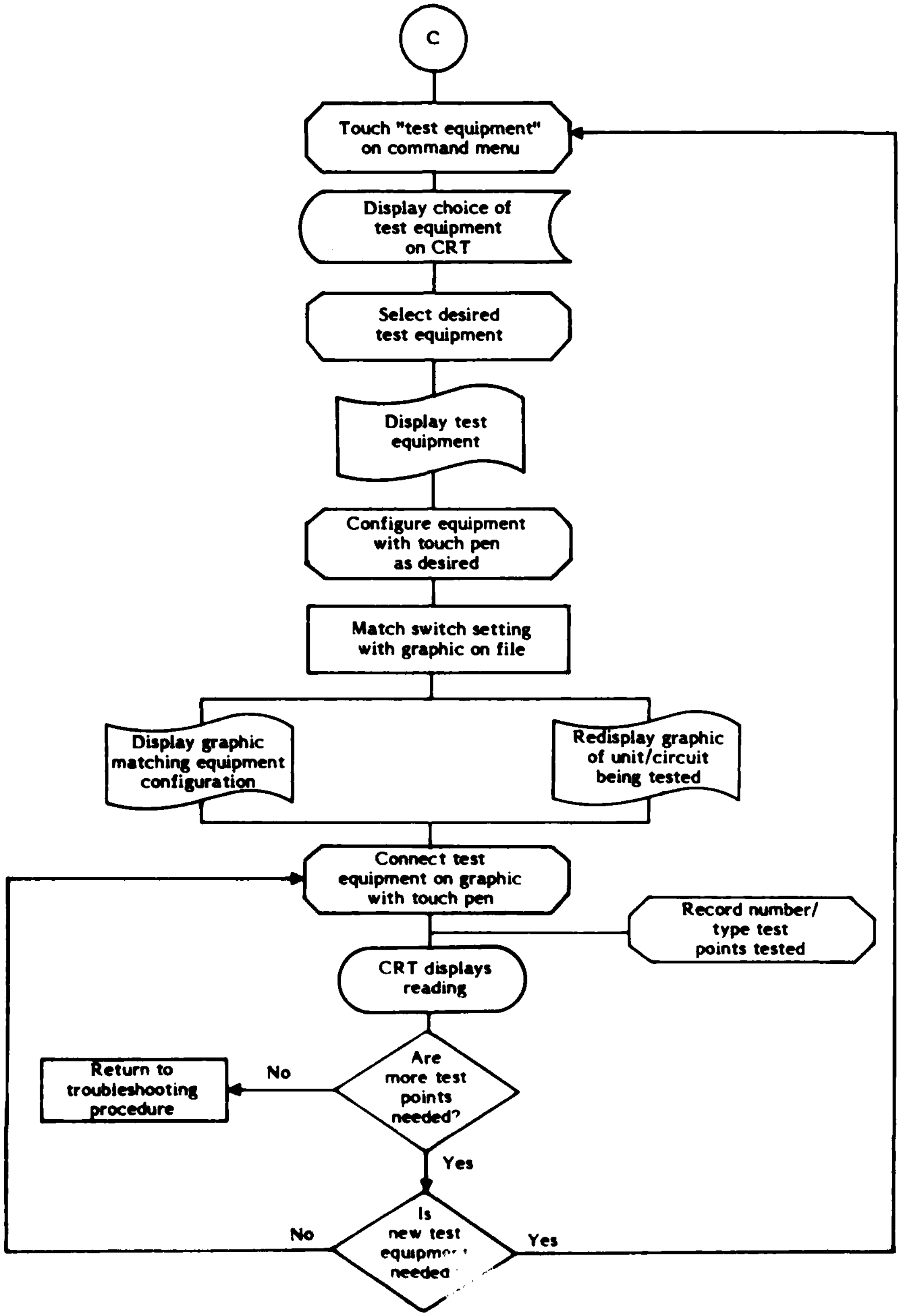


Figure 13. (Continued.)

Instance Specifications

The instance specification describes test conditions and standards. The instance specification section is divided into two subsections: type description and format description. The type description section describes the test conditions and includes such items as normal and faulted readings, tolerance, abnormal system operations, etc. The format description includes the method of student response for each objective. The two methods included are manual and/or automatic recording of student response data. Manual recordings consist of having a student use either a jobsheet or data entry device to record obtained system performance data (e.g., switch settings, meter or test readings). Automatic recordings require no direct student action. The system will record specified student action (e.g., switch settings, potentiometer adjustments) and provide feedback at a later time.

To ensure that the lesson specifications for the objectives included in each syllabus provided clear and accurate information and were sufficiently detailed to allow for the development of EEMT testbed instruction, an additional talk round was conducted. Drafts of the specifications were reviewed and critiqued in group meetings at the ET and EW schools. Topics of discussion included integration with existing lessons, time allocations and scheduling constraints, level of detail, tutorial and graphics presentation, and student performance evaluation. Revisions to the draft specifications were made as necessary during this round and incorporated into the final specifications.

RESULTS

Final curriculum outlines and corresponding lesson specifications were developed for three generic and three representative equipments to support EEMT system T&E in the ET and EW Class "A" schools. Individual lessons represent a combined total of approximately 208 EEMT system contact hours The generic curricula follow the general topic areas shown in Figure 14. The objectives are intended for presentation on the combined 2D/3D EEMT. Actual equipment lessons were designed to parallel existing objectives in the respective Class "A" school curricula. Representative equipment objectives are intended for presentation on the 2D EEMT only. Generic and representative equipment syllabi are separately described in the following subsections.

Common-core Objectives

Differences in prime equipments, hardware technologies, and identified variations in training approaches between the two schools served to limit the number of generic enablers that could actually be implemented in the target schools. In addition, the inordinately high number of curriculum hours that would be required to implement all 40 enablers and the inability to match certain non-hadware-oriented performance to EEMT system capabilities made the single syllabus approach impractical. The initial common-core curriculum would have required 11 weeks of instructional time. Actual allotted time for EEMT T&E curriculum implementation was limited to approximately 40 to 80 hours of instruction per school so as to stay within practical budgetary limitations for the T&E process. The initial curriculum also identified some common-core objectives that were deemed unsuitable for EEMT system presentation. These objectives included such items as "Identify maintenance procedures in a technical manual."

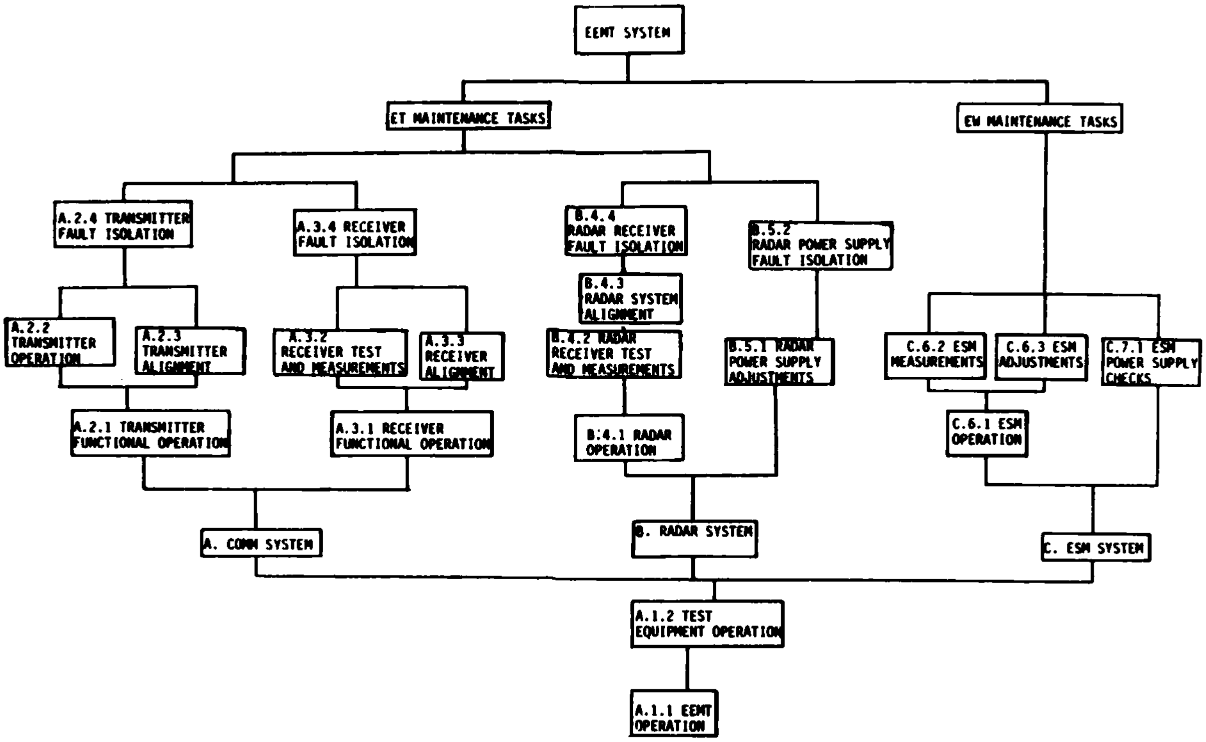


Figure 14. EEMT system syllabus hierarchy.

Of the 40 major enabling objectives, 26 were used in whole or in part in the final generic equipment curriculum outlines. Several objectives that were originally identified as representing common ET and EW tasks were presented for only one of the two schools. The selection process was greatly influenced by the difference in training emphasis; that is, troubleshooting vs. test and measurement. Table 2 lists the common-core objectives and the treatment applied for each.

ET "A" School Generic Curriculum

The ET "A" school generic system curriculum comprises five units of instruction representing approximately 69 EEMT contact hours. The first unit involves EEMT familiarization. The remaining four units include tasks associated with a generalized SSB transmitter, SSB receiver, radar system, and radar power supply. Each unit, with the exception of EEMT familiarization, incorporates preventive and corrective maintenance training tasks that support the acquisition of system and component troubleshooting skills. Test equipment of applications are incorporated as a component part of individual familiarization and troubleshooting objectives. Figure 15 shows the relationship between EEMT generic system lessons and the existing actual equipment lessons included in the present ET school curriculum. Table 3 lists corresponding objectives by curriculum objective numbers. The final ET "A" school generic system curriculum outline listing individual terminal and enabling objectives is presented in Appendix B.

Table 2

Treatment of Major Common-core Enabling Objectives

Common-core[a] Objective	Subject	Used in ET School	EW School	Treatment
1.1.1	Demonstrate familiarity w/EEMT	X	X	Applied in A.1.1
1.1.2	Demonstrate familiarity w/EEMT capabilities and limits	X	X	Applied in A.1.1
1.1.3	Demonstrate EEMT use	X	X	A.1.1
2.1.1	Energize simulated equipment	X	X	A.2.2.1, B.4.1.1 C.6.1.1
2.1.2	Test/operate simulated equipment	X	X	Incorporated in above objectives
2.1.3	Identify equipment-level maintenance procedures in a technical manual, etc.	--	--	No corresponding "A" school objective, applied in all maintenance tasks
2.1.4	Identify fault conditions existing in 2.1.2	X	--	Fault isolation not to be included in EW curriculum
2.1.5	Isolate fault conditions to equipment component	X	--	A.2.4.1, A.3.4.1, B.4.4.1
2.2.1	Perform T/S procedures (signal tracing and waveform analysis)	X	X	Applied in troubleshooting and test equipment objectives
2.2.2	Perform T/S measurements of voltage, current, and resistance	X	X	Applied in troubleshooting and test equipment objectives
2.2.3	Test simulated transistors	X	--	Applied in objective below
2.2.4	Use six-step T/S procedures to isolate faults	X	--	A.2.4.1, A.3.4.1, B.4.4.1 Fault isolation not included in EW curriculum
2.3.1	Remove and replace components	--	--	Not suitable for simulation
2.3.2	Remove and replace modules	--	--	Not suitable for simulation
2.3.3	Remove and replace parts	--	--	Not suitable for simulation
2.4.1	Align system synchros	X	--	Applied in objective A.2.2.2
3.1.1	Perform receiver tests and measurements	X	X	A.3.2.1, C.6.2.2, also A.3.1.2, B.4.3.1, and C.6.3.1
3.2.1	Perform video/audio gain adj.	--	--	T&E curriculum time constraints
3.3.1	Perform receiver alignment to IF amp, RF amp, beat freq. osc.	X	--	A.3.3.1
4.1.1	Perform transmitter test and measurements	--	--	T&E curriculum time constraints
4.1.2	Identify fault conditions	X	--	Included in objective A2.4.1
4.1.3	Isolate fault conditions	X	--	A.2.4.1
4.2.1	Adjust transmitter frequency	X	--	Included in objective A.2.3.1
4.2.2	Align transmitter	X	--	A.2.3.1
5.1.1	Perform antenna tests and measurements	--	--	T&E curriculum time constraints
5.1.2	Identify antenna fault conditions	--	--	T&E curriculum time constraints
5.1.3	Isolate antenna fault conditions	--	--	T&E curriculum time constraints
6.1.1	Perform power supply tests	X	X	B.5.1.1, C.7.1.1
6.1.2	Adjust power supply	X	X	B.5.1.2, C.7.1.2
6.1.3	Identify power supply fault conditions	X	--	Included in objective B.5.2.1
6.1.4	Isolate power supply fault conditions	X	--	B.5.2.1
7.1.1	Perform control/monitor tests and measurements	X	--	Included in objective B.4.3.1
7.1.2	Adjust control/monitor	--	--	T&E curriculum time constraints
7.2.1	Perform teletype tests	--	--	T&E curriculum time constraints
7.2.2	Perform teletype adjustments	--	--	T&E curriculum time constraints
8.1.1	Run systems operational test	--	X	C.6.1.1
8.1.2	Run system diagnostic tests	--	X	Similar to task above
8.1.3	Identify in-and-out of tolerance responses	--	X	C.6.2.1 and C.6.2.2
8.2.1	Perform tests and measurements on digital circuits	--	--	T&E curriculum time constraints
8.2.2	Identify digital circuit fault conditions	--	--	T&E curriculum time constraints
8.2.3	Isolate digital circuit fault conditions	--	--	T&E curriculum time constraints

[a]Numbers refer to those included in the respective ET and EW T&E syllabi presented in Appendices B and C.

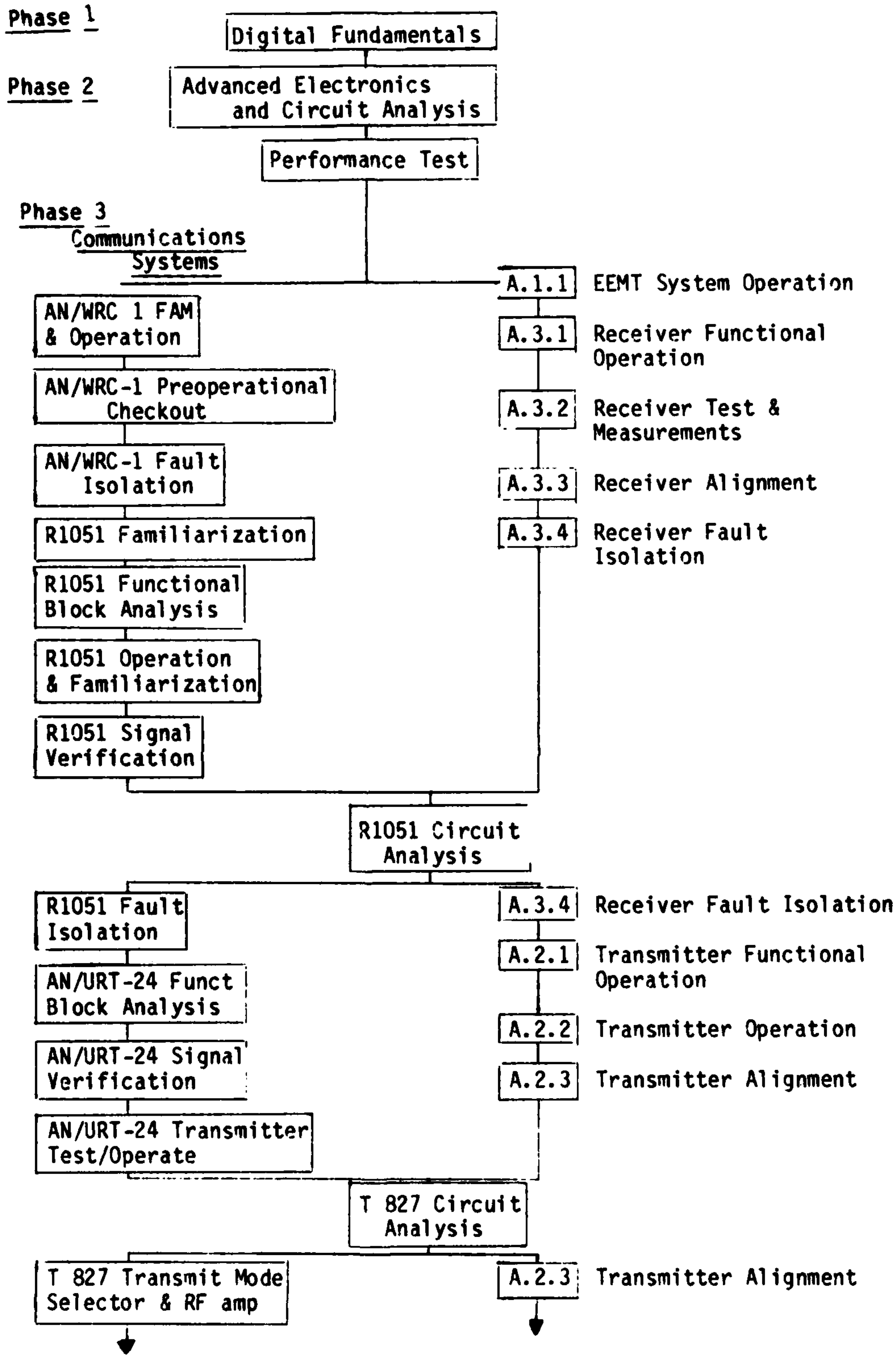


Figure 15. ET "A" school generic T&E syllabus lessons.

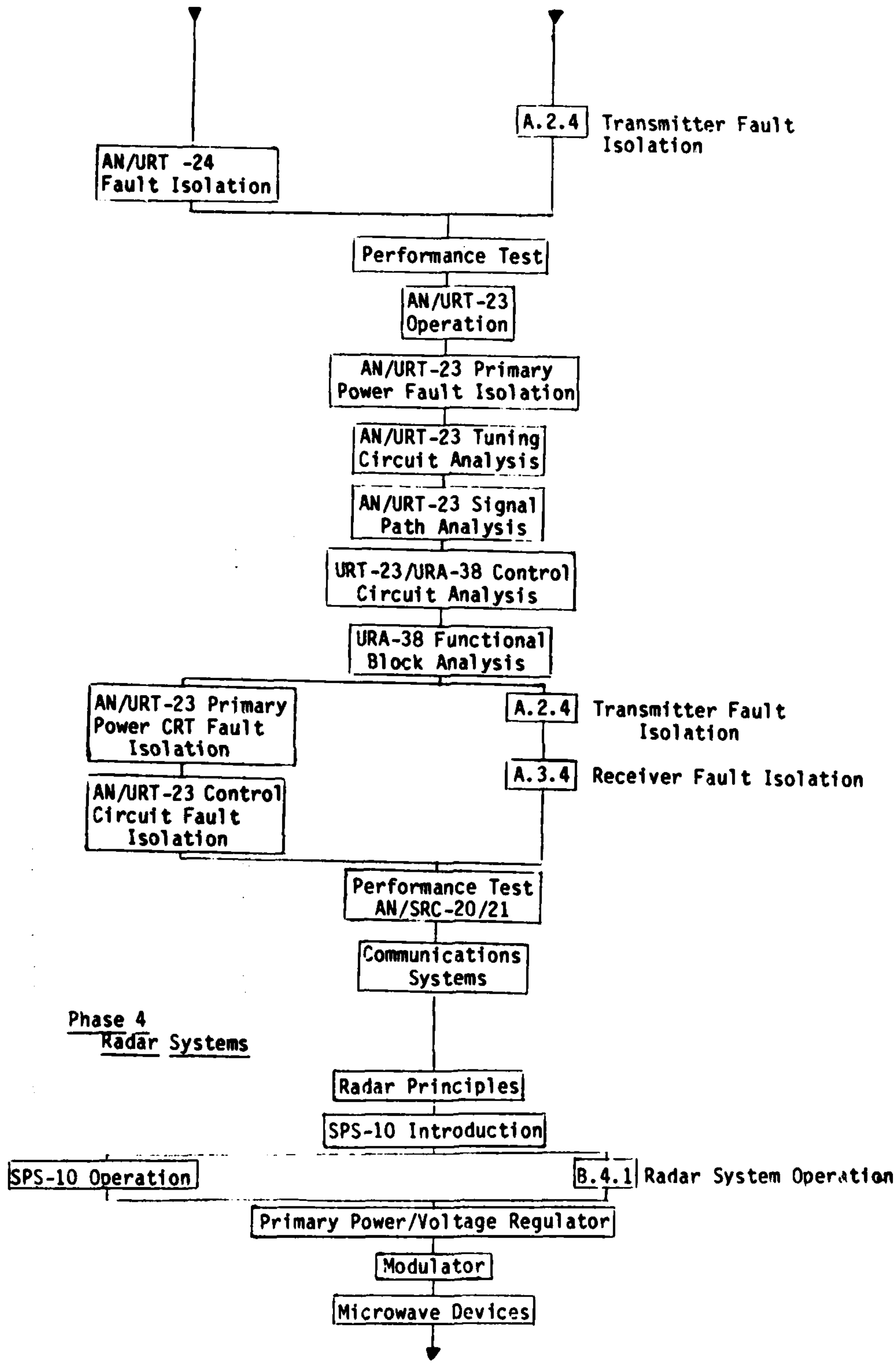


Figure 15. (Continued.)

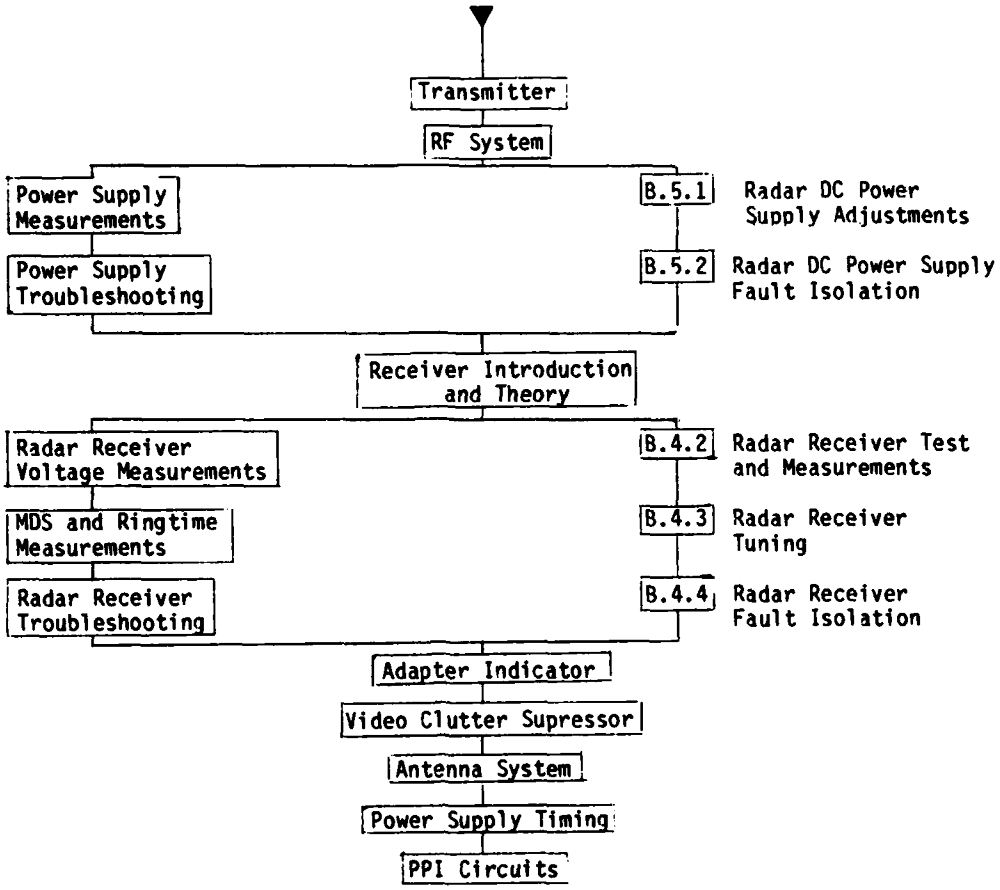


Figure 15. (Continued.)

Table 3

Corresponding Generic System and ET "A" School Objectives

EEMT Objective Number	Topic Area	ET "A" School Objective Number
A.2.1.1	SSB fundamentals	3.1.3.2.1
A.2.2.1	SSB transmitter turn-on	3.1.1.1.3, 3.1.3.1.2
A.2.2.2	Antenna tuning	3.1.4.3.4
A.2.2.3	Transmitter operation	3.1.3.1.2
A.2.3.1	Transmitter alignment	3.1.3.4.7, 3.1.3.7.5
A.2.4.1	Transmitter fault isolation	3.1.1.1.5, 3.1.4.2.5
A.3.1.1	Receiver fundamentals	3.1.2.2.1
A.3.2.1	Receiver operations	3.1.2.1.2, 3.1.1.1.3
A.3.2.2	Receiver sensitivity test	3.1.2.4.4
A.3.3.1	Receiver alignment	3.1.2.6.5
A.3.4.1	Receiver fault isolation	3.1.1.1.5, 3.1.4.2.5
B.4.1.1	Radar operations	4.1.1.4.3, 4.1.1.4.2J
B.4.2.1	Radar sensitivity test	4.2.4.6.7
B.4.3.1	Radar alignment	4.2.4.6.1-6
B.4.4.1	Radar fault isolation	4.2.4.6.8
B.5.1.1	Power supply function	4.2.3.2.1
B.5.1.2	Power supply alignment	4.2.3.2.2
B.5.2.1	Power supply fault isolation	4.2.3.2.3

EW "A" School Generic Curriculum

The generic system curriculum for the EW Class "A" school is divided into three units of instruction representing 40.5 EEMT contact hours. The first unit includes EEMT system familiarization and lessons dealing with test equipment operation and applications procedures. The second unit is directed toward ESM system preventive maintenance tasks including operational checks and measures, tests of receiver sensitivity, noise levels, false alarm rates, and correlation timing adjustments. The third unit addresses maintenance tasks associated with a generalized system power supply and includes functional checks and adjustments. Figure 16 shows the relationship between EEMT generic system lessons and the existing training flow. Unlike the EEMT generic system curriculum for the ET "A" school, EW objectives are organized so as to be implemented in a single "chunk" of instruction that is placed between ESM equipment operation (operation checks) and equipment test and adjustment. It is seen as a transitional activity for the accquisition of test and measurement skills. Since the EW "A" school curriculum is undergoing extensive revision, it was not possible to match objectives as was done for the ET "A" schools. The final EW "A" school generic system curriculum outline listing individual terminal and enabling objectives is presented in Appendix C.

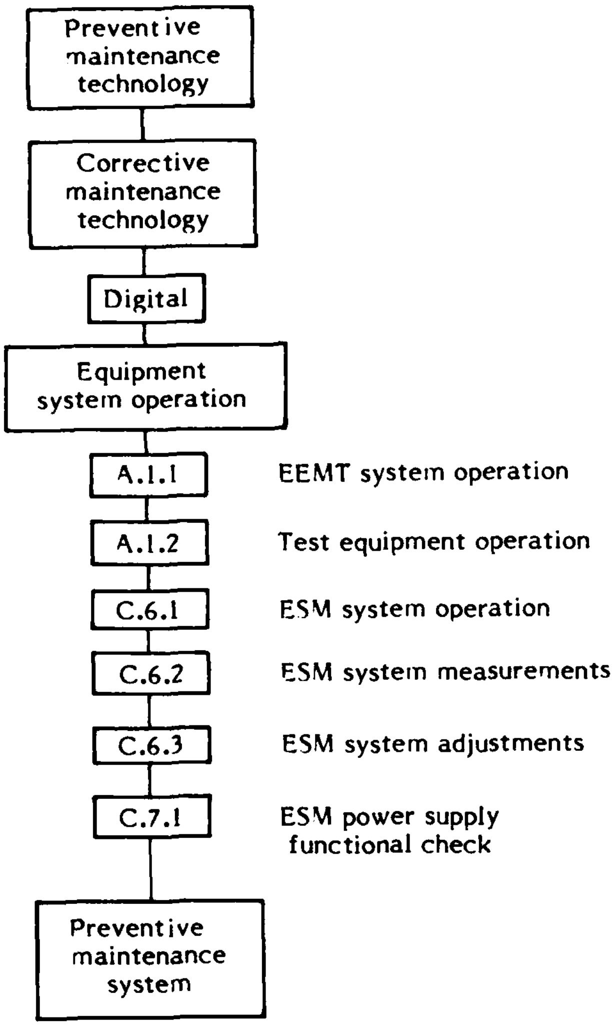


Figure 16. EW "A" school EEMT generic T&E syllabus lessons.

2D/3D Unit Task Distribution (Generic Systems)

Generic syllabi were sequenced to provide 2D activity followed by a practice on the 3D unit. The procedures for operating test equipment (EW school only) were selected as 2D tasks while actual measurement tasks were assigned to the 3D. Non hands-on instructional materials were assigned entirely to the 2D. System operation, tests, alignment, and troubleshooting tasks were designated as either 2D/3D, depending on which unit best met requirements for that particular task.

Table 4 shows the number and percentage of system maintenance segments per media choice; and Table 5, the total number of hours per media choice for the combined "A" schools. In determining the overall ratio of 2D to 3D, the segments that called for a repetition of operation, first on 2D and then 3D, were seen as having the hours split evenly between the two modes. The remaining segments require that the student begin preliminary operations on the 2D unit as a preview and then perform the actual task on the 3D. These tasks were seen as having a time ratio of 20/80 between 2D and 3D, based on the number of steps to be accomplished on either unit. Therefore, of the 33.5 hours devoted to the 2D/3D combination, 13.5 hours were designed as 2D activities and 20 hours as 3D activities. The total EEMT media ratio is estimated to be 63 hours of 2D to 43.5 hours of 3D, or a 60/40 split.

Table 4

Number and Percentage of System Maintenance Tasks Per Media Selection

Task	2D	%	2D/3D	%	3D	%
OPS	4	67.0	2	33.0	0	--
Test	2	33.0	2	33.0	2	33.0
Align	1	12.5	2	25.0	5	62.5
T/S	4	100.0	0	--	0	--
Total	11	46.0	6	25.0	7	29.0

Table 5

Hours of Instruction Per Media Selection for ET and EW Class "A" Schools

Item	2D	2D/3D	3D
Familiarization	1.0	2.0	--
Test equipment	--	12.0	--
Tutorial	6.0	--	--
System operation	13.5	4.0	--
System tests	4.0	10.5	5.0
System alignment	3.0	5.0	18.5
System troubleshooting	22.0	--	--
Total hours	49.5	33.5	23.5
40/60 split of 2D/3D	13.5		20.0
Total	63.0		43.5

Representative Equipment Curriculum

Representative equipment curriculum outlines were developed as supplements to existing "A" school curricula. Objectives selected and approved for 2D EEMT implementation were similar in content and organization to those for the generic equipment curricula and corresponded to the requirements and constraints stated for the target schools. Representative equipment curricula for ET "A" school include the AN/WSC-3 satellite communications system and the AN/SPS-10 radar set. Consistent with the ET school training approach, each representation equipment curriculum was arranged in a learning hierarchy of dependencies. Objectives dealing with specific concepts (i.e., system operating characteristics, components and functions, etc.) are presented first, followed in sequence by procedure-oriented lessons and practice in fault isolation. Lesson specifications, including simulation data base requirements, were then prepared using available operation and maintenance documentation for that system.

AN/SPS-10 Radar Set

The developed AN/SPS-10 radar syllabus represents approximately 25 2D EEMT contact hours. Individual EEMT objectives were matched to existing ET "A" school curriculum objectives and sequenced as illustrated in Figure 17. The correspondence between EEMT and ET "A" school objectives is shown in Table 6. The approved EEMT AN/SPS-10 radar set curriculum outline is presented in Appendix D.

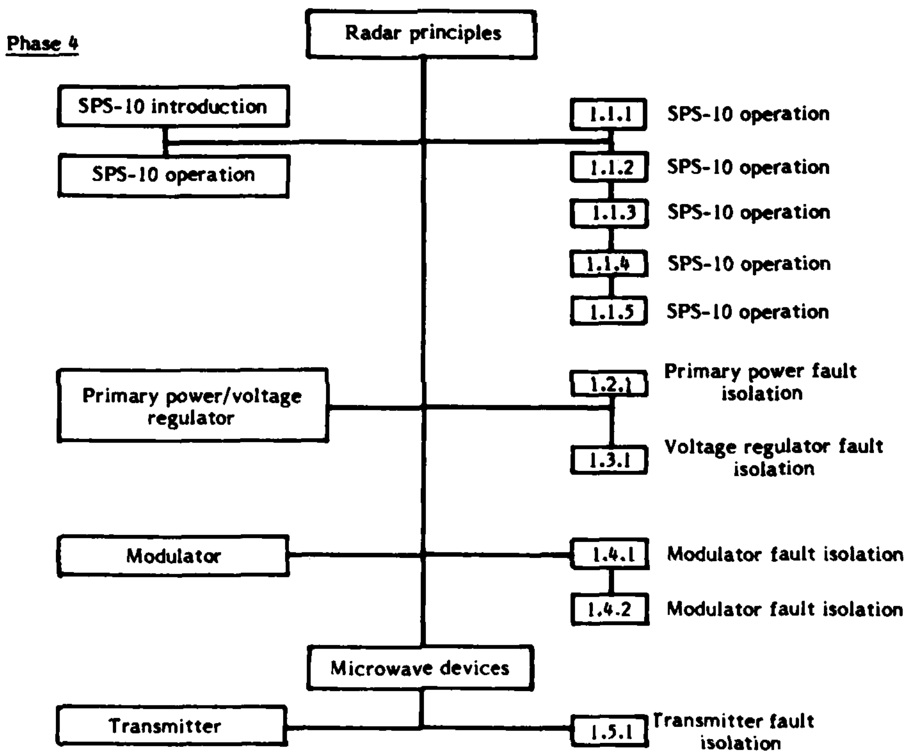


Figure 17. EEMT AN/SPS-10 syllabi.

Table 6

Corresponding EEMT and ET "A" School Objectives

Objective Number	EEMT Objective Title	ET "A" School Objective
1.1.1	System component location	4.1.1.4.2
1.1.2	System controls and their effects on system	4.1.1.3.7
1.1.3	System turn on/off and adjustments	4.1.1.4.3
1.1.4	Block diagram unit functions	4.1.1.3.3
1.1.5	Fault isolation of system to components	
1.2.1	Fault isolation of primary power circuit	4.1.2.1.6
1.3.1	Fault isolation of AC voltage regulator	4.1.3.1.6
1.4.1	Fault isolation of modulator trigger pulse generator	4.1.4.1.25
1.4.2	Fault isolation of modulator pulse generator	4.1.4.2.13
1.5.1	Fault solation of transmitter metering section	4.2.1.3.5

AN/WSC-3 Satellite Communication Set

The AN/WSC-3 satellite communications set is not presently available or taught in the ET "A" school. It is, however, planned for installation in the near future and the start of training could possibly coincide with EEMT system T&E. Objectives selected and approved for this equipment represent approximately 30 2D EEMT contact hours. Included objectives were organized so as to be compatible with the existing training approach and in general follow the hierarchy of dependencies established for EEMT lessons. The AN/WSC-3 communications set represents the state-of-the-art in hardware technology and differs significantly in terms of diagnostic and troubleshooting procedures currently being taught in the equipment laboratories. These differences are primarily related to the modular construction of the hardware system and the emphasis to be placed on the use of built-in-test equipment (BITE) fault isolation procedures. The extent of these differences are reflected in individual lesson specifications. The approved AN/WSC-3 curriculum outline is presented in Appendix E.

AN/SLQ-32 Electronic Support Measures (ESM) System

The AN/SLQ-32 ESM system objectives selected and approved by EW school personnel represent approximately 44 2D EEMT contact hours. Individual objectives parallel those selected for the generic ESM system and focus primarily on system preventive maintenance test and measurement tasks. They include the application of specific test equipment to practice alignment adjustment and testing of various system components. The AN/SLQ-32 ESM sytem curriculum outline is presented in Appendix F.

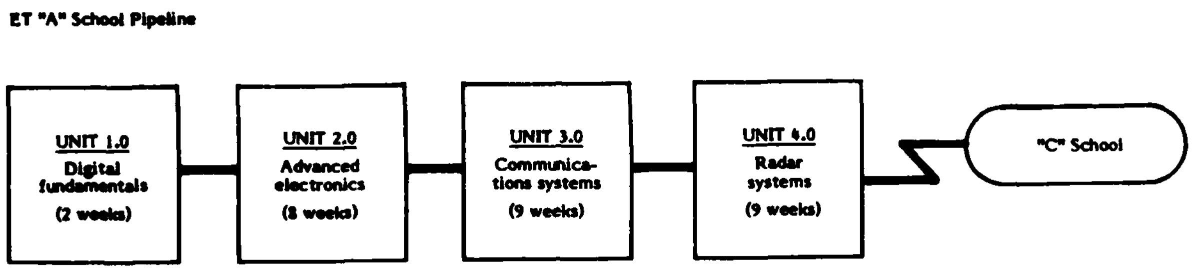
DISCUSSION

The lesson objectives resulting from the E-T-E interactions varied considerably between the two Class "A" schools. Preliminary analyses conducted as a part of the initial estimate round uncovered certain differences in the underlying philosophies and approaches used by the two schools to teach electronics and electronic equipment

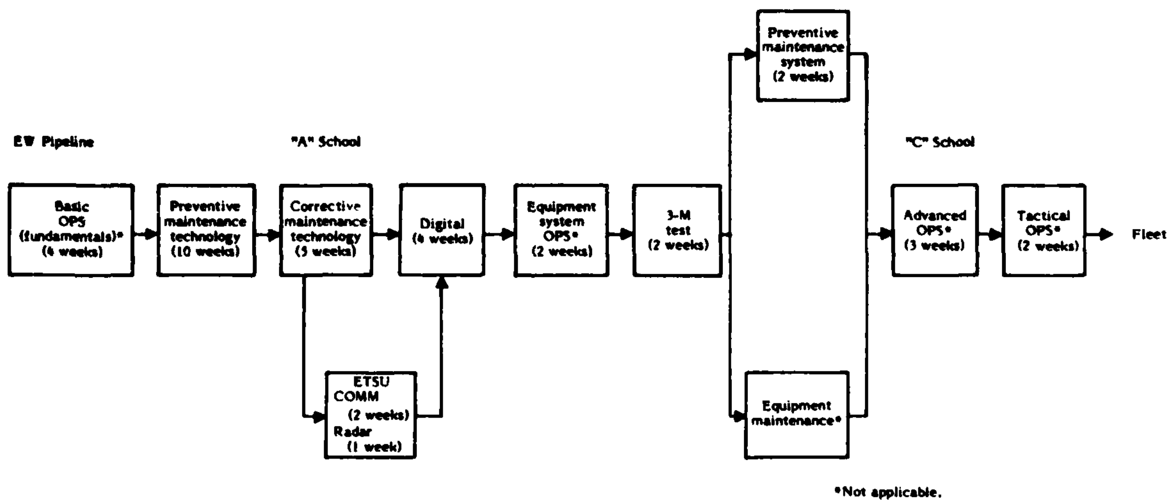
maintenance. Figure 18, which illustrates the general flow of instruction supported by the two curricula, shows that both schools address electronics fundamentals, advanced electronics, and electronic maintenance training. Within this structure, both schools also share an actual equipment approach to maintenance training. However, the ET school has a relatively large and diverse equipment inventory corresponding to the range of equipments and equipment families an ET may be required to maintain in the fleet. Many of the equipments in the inventory are relatively old and approaching obsolescence. More advanced systems are typically learned at the "C" school level. Conversely, the EW school has a smaller and less diversified equipment inventory. EW equipments are technically more advanced and also more closely aligned with the equipment that the EW will ultimately be required to maintain in the fleet. The EW "A" school can therefore maximize actual equipment approach by tailoring its curriculum to meet actual fleet system maintenance requirements. The ET "A" school can only hope to provide training that will generalize to the more advance systems that will later be introduced in the training pipeline.

The noted equipment differences also contribute to other more practical training differences between the two schools. The ETs are trained using actual equipment representing vacuum-tube and solid-state technology while the EWs work with more advanced equipment using solid-state and IC technology. ET training is heavily trouble-shooting-procedure-oriented and is designed to isolate faults from components to parts. EW training relies more on built-in test equipment and diagnostics for fault isolation and emphasizes preventive maintenance checks and procedures. Another important difference involves the integration of test equipment into the training processes. The EW school explicitly trains the use of test equipment, while the ET school assumes these skills and knoweldges have been previously learned and incorporates test equipment tasks within the context of other laboratory activities.

The generic electronics training syllabus developed during the EEMT system definition phase was designed to provide a common curriculum that could be shared by the target schools. That initial effort was performed almost wholly at the task, equipment, and electronic technology level and was not influenced by the constraints imposed by the schools. Based on the results of that initial curriculum design effort, there is little doubt that many areas within electronic training syllabi can be combined at the task level. However, commonality has proven to be a function of the equipment level being analyzed and decreases as one moves from the component level upward through the hardware system (Pine, Daniels, & Heeringa, 1979). Commonality at higher equipment levels tends to remain within equipment families and within like technologies. This relationship also applies to system operational checks that involve such tasks as initial setup of component controls, verification of component status, and adjustment of controls for displaying and monitoring system information. These functions are essentially generic but the details of what controls are set and what adjustments are made again fall more readily in the domain of equipment families. These precepts, coupled with the observed differences in actual equipment applications and training approaches in the two schools, virtually precluded the implementation of a single syllabus for testing generic systems training. Separate generic syllabi based on equipment family characteristics, as described in the Results section of the report, were therefore developed. Each syllabus was designed to parallel similar objectives in the representative equipment training tracks so that experimental and control group procedures could be used to generate evaluation data. While objectives matching was a relatively straightforward process, generality content differed along the lines previously discussed.



a. ET "A" school pipeline.



b. EW "A" school pipeline.

Figure 18. ET/EW training pipelines.

Of interest was the manner in which the generic system concept was perceived by training experts at the two schools. For most, the generic concept was closely equated with content taught in basic electricity and electronics (BE&E) training. The consensus appeared to be that generic system training would best be implemented as a separate pipeline course that would precede the hands-on prime equipment training in the Class "A" schools. The overriding concern was that required equipment-specific skills and knowledges would not transfer. The net effect would simply be to introduce a series of non-system-related training modules into an already crowded world of real systems.

The above noted perceptions did not hold true for the representative equipment syllabi developed for implementation on the 2D trainer/simulator only. The capability of the 2D trainers to support concept- and procedures-level learning tasks and to provide a practice vehicle for operating and troubleshooting actual equipment was universally accepted. This is not to say that the 2D trainer/simulator satisfied all expectations for a computer-based training system, but it was recognized as having great potential for supplementing and extending both classroom and laboratory training.

CONCLUSIONS

The lessons selected for use during the EEMT project T&E phase constitute a reasonable but limited sampling of common-core and equipment-specific objectives suitable for implementation on the EEMT 2D and 3D trainer components. Objectives were selected and lessonware specifications were prepared within the constraints established for EEMT system T&E and for those identified for the target schools. The ability to meet these developmental goals was, by and large, a result of using the E-T-E methodology during the initial objectives selection and matching process.

The goals for developing a common-core generic curriculum outline and lessonware specifications to support EEMT system T&E at the two training sites were met with only marginal success. These results were partialy anticipated in light of known differences in hardware technology, but the assumption of compatibility of objectives between the target schools proved to be invalid in approximately 75 percent of the cases. The area of system test and measurement initially appeared to afford the greatest opportunity for implementing common-core generic training. However, this area is treated differently within the two schools and does not allow for the implementation of common training objectives or for the development of a common package. Owing to the unique design of the 3D EEMT in which generalized test equipments are employed, it may ultimately be possible to achieve a fairly high degree of commonality within this area. This will, however, require that the 3D concept prove effective and that a standard curriculum approach to training test equipment and test equipment applications be adopted within the electronics training community.

Despite the equipment and training differences between the two schools, it was possible to prepare specific EEMT curriculum outlines and lessonware specifications that support the learning of generic principles involved in electronic equipment maintenance and troubleshooting. It was also possible to provide objectives and lessonware specifications to supplement existing actual equipment training. The developed syllabi incorporate instruction in both concept and procedures learning tasks and also provide for practice in fault isolation using the top-down approach characteristic of the EEMT simulation data base structure. It is therefore concluded that this approach to simulation for training affords great flexibility of application and can be successfully intgrated into a variety of existing electronic-oriented training programs.

It is anticipated that one of the most effective applications of the EEMT system will be in the area of training fault isolation skills. Presently there are few options available to electronics instructors for inserting faults into prime laboratory equipment without endangering the students or the equipment. None of the options provide cues, prompts, help, or directive feedback to the students but, instead, rely on intimate student-instructor interaction for skills acquisition. The EEMT should increase both the number and type of problems that can be made available to a student. Individual problems can be structured to provide a cognitive orientation through directive guidance and feedback, or unstructured to allow for exercising various cognitive processes such as hypothesis formation and testing. The range of possible training options and specific applications covered in the testbed syllabus are considered very limited in scope. Table 7 lists additional ET "A" school curriculum topics that are candidates for 2D EEMT applications.

RECOMMENDATIONS

1. Given the limited success achieved in the selection and matching of existing curriculum objectives and the recognized need to deal with electronic equipment family related issues at both the objectives and lessonware specifications levels, it is recommended that OP-115 alter the T&E effort to allow for the implementation of a stand-alone test of generic systems maintenance training. This would allow for a more complete test of the training effectiveness, transfer of training, and the generalizability of maintenance task categories. It would also assist in determining where generic systems training can most effectively be placed in the general flow of technical training.

2. Because EEMT simulation and training data base development requires a relatively unique mixing of subject matter expertise, video production, and word processing system skills, it is recommended that CNTT provide one or two EEMT 2D trainers/simulators to the school and/or the supporting Education and Training Program Development Center Detachment a minimum of 6 months prior to the installation of training units. Planning for simulation and training data base development would be undertaken approximately 1 year prior to initial installation.

3. It is recommended that CNTT consider expansion of the representative equipment T&E syllabi to allow for full EEMT system implementation in the respective Class "A" schools at the earliest possible time.

Table 7

Additional EEMT Applications for ET "A" School

Topic Number	Topic	Lab Hours	Classroom Hours	Possible EEMT Hours
Phase 2:				
2.1.1	Elements radio communication	0.0	6.0	6.0
2.1.2	Communication systems	0.0	6.0	0.0
2.2.1	Modulation principles	12.0	6.0	15.0
2.3.1	Single sideband fundamentals-TX	18.0	6.0	20.0
2.3.2	Single sideband TX circuits	39.0	32.0	36.0
2.3.3	Single sideband fundamentals-receiver	6.0	3.0	8.0
2.3.4	Single sideband receiver circuits	21.0	10.0	17.0
2.4.1	Frequency modulation funamentals-TX	9.0	3.0	8.5
2.4.2	FM transmitter circuits	10.0	2.0	6.
2.4.3	Frequency modulatin fundamentals-receiver	4.0	2.0	4.0
2.4.4	FM receiver circuits	16.0	6.0	13.5
2.5.1	Radio frequency transmission	7.0	4.0	9.0
2.5.2	Corrective maintenance repair/ replacement	11.0	1.0	1.0
Total		153.0	87.0	144.0
Phase 3:				
3.1.1	AN/WRC-1	12.0	6.0	18.0
3.1.2	R-1051/URR	18.0	12.0	17.5
3.1.3	AN/URT-24	18.0	12.0	17.5
3.1.4	AN/URT-23 and AN/URA-38	39.0	21.0	40.0
3.2.1	AN/SRC-20.21 and AN/SRA-33	27.0	33.0	26.0
3.3.1	Introduction to communications systems	0.0	3.0	0.0
3.3.2	HF FSK (RCS) system	14.0	8.0	3.0
3.3.3	UHF AFTS system	6.0	3.0	4.0
3.3.4	HF multiplex (AFTS) system	13.0	7.5	0.0
3.3.5	CW system	6.0	2.5	6.5
3.3.6	Voice operated relay system	6.0	3.0	0.0
Total		159.0	111.0	132.5
Phase 4:				
4.1.1	Introduction to AN/SPS-10	6.5	19.5	26.0
4.1.2	Primary power distribution	8.0	9.5	8.0
4.1.3	AC voltage regulator	5.0	5.5	5.0
4.1.4	Modulator	9.0	13.5	8.0
4.2.1	Transmitter	6.5	14.5	5.5
4.2.2	RF system	2.0	1.5	2.0
4.2.3	DC power supply	6.5	7.5	6.5
4.2.4	Receiver	12.0	14.5	12.5
4.3.1	Adapter indicator	8.5	5.0	7.5
4.3.2	Video clutter suppressor	0.0	2.5	0.0
4.3.3	Antenna system	10.0	12.5	8.0
4.4.1	Power supplies/timing	30.0	19.5	27.0
4.4.2	Sweep and DRA sections	19.0	15.0	13.0
4.4.3	Brightening section	11.0	7.5	7.5
Total		134.0	148.0	136.5
Overall Total		446.0	346.0	413.0

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APPENDIX A

QUESTIONNAIRE FOR TENTATIVE EEMT CURRICULUM OUTLINE

QUESTIONNAIRE FOR TENTATIVE EEMT CURRICULUM OUTLINE

The tentative EEMT curriculum outline was developed as a "strawman" to identify objectives in the ET and EW "A" school curricula that could be trained on EEMT. This questionnaire was designed as a tool to systematically review and critique the content of the tentative EEMT curriculum outline. There are two goals to be accomplished by evaluating the objectives in the tentative outline. First, you are asked to determine the feasibility of the potential EEMT 2D and 3D applications. Your inputs will be used to estimate the potential number of hours of EEMT instruction in the ET and EW curricula to derive life cycle cost estimates for EEMT curriculum development. Secondly, you are asked to select objectives to be included in the 40 to 80 hours of EEMT instruction to be developed for operational test and evaluation. Your inputs will be used to develop lesson specifications for the EEMT testbed modules.

The criteria for selecting ET and EW "A" school objectives for EEMT instruction are based on the performance goals specified in the operational requirement for the Class "A" electronic equipment maintenance training system and the operational issues identified in the draft device test and evaluation master plan. These selection criteria are summarized in the questionnaire and then phrased as questions to be used in evaluating the content in the tentative EEMT curriculum outline.

The questionnaire is divided into two parts. Part 1 contains questions concerning equipment related issues, while Part 2 contains questions concerning training improvement issues. Part 1 addresses five major selection criteria, which are designated as I, II, III, IV, and V. You are asked to write your responses to the questions directly on the tentative EEMT curriculum outline in the columns designated as I, II, III, IV, and V. Part 2 addresses one major selection criteria, which is designated as VI. Again, you are asked to write your responses to questions directly on the tentative EEMT curriculum outline in the column designated as VI. Further instructions are also provided within the body of the questionnaire.

You are asked to evaluate the content of the tentative curriculum outline on the basis of your expertise and involvement in the program. Additional responses, comments, and concerns are solicited. Please feel free to write any additional information or comments directly on the questionnaire. Thank you for your participation.

PART 1—EQUIPMENT-RELATED ISSUES

I. Operational Concept

As stated in the operational requirement:

> The traditional Navy electronics training system teaches electronics maintenance in ever increasing dimensions, from the simple (i.e., basic theory, components, etc.), to the most complex (i.e., integrated system(s)). There is a heavy dependence on specific operational equipment to support this training in the equipment phase of "A" school training and "C" school. Analysis of equipment maintenance task commonality and electronics maintenance personnel utilization patterns suggests the need for a significantly different concept of electronics maintenance training for application at the "A" school level that capitalizes on the high degree of common maintenance tasks found to exist among electronics equipment. The proposed training system concept centralizes the subject matter to "Generic Systems," and lends itself to the utilization of generic (i.e., having general application) simulation equipment for hands-on training in lieu of specific operational equipments. The concept emphasizes the interrelationship of the generic systems signal processing functions (e.g., RF, IF, video, etc.) found within families of equipment. The instructional sequence will teach generic systems principles by functional categories (receivers, transmitters, etc.) and in terms of the signal processing functional elements that characterize these equipments. Defined common-core equipment maintenance tests and measurements, by categories, will be taught with respect to the generic families of equipments upon which they are performed and the signal processing functions involved. The training objectives for the apprentice technician will focus on the intra-signal processing function tests and mesurements, or on both intra- and inter-system signal processing function test and measurements, including areas of generic troubleshooting logic and decision making. This training concept emphasizes, in both academic and laboratory situations, performance-based, hands-on instruction in guiding and correcting each student as he attempts to carry out his prescribed task, using interactive, computer-based training devices to support the curriculum, thus reducing the need for multiple devices of fleet operational equipment in the school. The training devices will possess computer-assisted and computer-managed instructional capabilities to augment self-paced training, trainee testing, and scheduling.

One of the performance goals for EEMT is to "rapidly adapt to changing personnel job demands in response to changing personnel utilization patterns and/or changes in associated equipment that affect job demands."

Which of the objectives in the tentative outline emphasizes tasks, skills, and knowledge that will generalize to the larger population of equipments to be maintained by ETs and EWs? Please indicate whether the tasks, skills, and/or knowledge for each objective is generalizable by writing "Yes" or "No" in column 1 of the tentative curriculum outline. Your responses will be used to determine applications for EEMT and the total potential number of hours of EEMT instruction.

II. Criteria for Bridging the Gap

All students entering the electronics-oriented "A" schools have received instruction in the Basic Electricity and Electronics (BE/E) course and most of them will receive further instruction in equipment-specific "C" schools. Class "A" school training progresses through electronics fundamentals training using classroom instruction augmented by specific training devices to troubleshooting and "hands-on" training supported by prime equipment laboratories. The transition from BE/E to the fundamentals phase and then to the equipment phase poses problems for both students and instructors. EEMT is designed to bridge the gap that currently exists between electronics fundamentals training and equipment-specific operational practices in the Class "A" schools.

Which of the objectives in the tentative EEMT curriculum outline will improve the transitions from electronics fundamentals to equipment-specific segments?

A. Where are the critical transition areas in the curriculum? Please identify the objectives by marking "A" in column II of the tentative curriculum outline.

B. Where should the emphasis be placed? Please identify the objectives by marking "B" in column II of the tentative curriculum outline.

C. Are these transitions common or specific to the ET or EW pipeline? Please identify the objectives by marking "C," "ET," or "EW" in column II of the tentative curriculum outline.

Are there any considerations or constraints for inserting and sequencing the EEMT instruction into these transition areas? For example, what student entry level is required to accomplish these objectives? Please write your responses in the space provided below.

III. Criteria for Individual Hands-on Training

EEMT can provide more performance-oriented training without increasing the hours of training in the prime equipment laboratories. The 2D/3D capability permits practical "hands-on" type exercises immediately after the presentation of conceptual information. In this way, troubleshooting techniques can be introduced and practiced during the fundamentals phase through the equipment phase, rather than just in the equipment phase. This allows more efficient utilization of laboratory time, with the emphasis on using prime equipment for performance testing, rather than equipment familiarization and troubleshooting practice.

Examples of providing performance-oriented training without increasing the hours of laboratory time using prime equipment include:

1. Introduce the six steps of troubleshooting in the first week.
2. Introduce the organization and use of technical manuals in the initial weeks.
3. Provide practice finding, interpreting, and using schematics diagrams and block diagrams.
4. Provide familiarization with representative system/subsystem/component breakdowns.
5. Provide for representative system buildup from the component level.
6. Provide practice using test equipment.
7. Introduce the maintenance and material management (3M) system.
8. Provide familiarization with preventive maintenance system (PMS) and maintenance requirement cards (MRS).

Which of the objectives in the tentative outline will provide individual hands-on laboratory training experiences in maintenance procedures while minimizing the dependence on prime equipment to support this requirement?

Are there any training devices in use in the existing curriculum to support these performance-oriented objectives? Please identify the objectives by marking "Yes" (if trainng devices exist) or "No" (if there are no training devices) in column III of the tentative curriculum outline.

Are these objectives common or specific to the ET or EW pipeline? Please identify the objectives by marking "C," "ET," or "EW" in column III of the tentative curriculum outline.

Are there any considerations or constraints for inserting and sequencing the EEMT instruction into these transition areas? For example, what student entry level is required to accomplish these objectives? Please write your responses in the space provided below.

IV. One of the performance goals specified in the operational requirement calls for EEMT to reduce the reliance on prime equipment for maintenance training.

Which of the objectives in the tentative outline will allow EEMT to demonstrate reduced reliance on prime equipment? Are there areas in the existing curriculum where there are problems with prime equipment availability for maintenance training due to:

A. Equipment maintenance and downtime.

B. Obsolete equipment.

C. Insufficient quantities.

D. Scheduling constraints.

E. Other (please specify).

Please identify the objectives by marking "A," "B," "C," "D," and/or "E" in column IV of the tentative curriculum outline.

V. Criteria for Differing Technology

As stated in the operational requirement:

> The training system will have to prepare personnel to meet the job demands dictated by older discrete component, vacuum-tube technology as well as solid state, large-scale integration technology including computer-controlled operations. Fundamentals training is currently provided for vacuum-tube, transistor, integrated circuit, discrete component, and digital technologies with outdated or insufficient numbers of training devices in the laboratory or no laboratory exercises. As a computer-based instructional system, EEMT can provide interactive training for these differing technologies.

Which of the objectives in the tentative outline will demonstrate training for differing technologies?

Please indicate the relevant technology(s) for each objective by marking "A," "B," "C," or "D" in column V of the tentative curriculum outline.

A. Vacuum-tube, discrete component technology?

B. Modularized, discrete component technology?

C. Modularized, integrated circuit technology?

D. Modularized, monolithic (MIS, LSI) technology?

PART 2--TRAINING IMPROVEMENT ISSUES

VI. Criteria for Test and Evaluation

One of the critical issues to be evaluated during operational test and evaluation is whether EEMT can lead to a training improvement of at least 10 percent in terms of reduced training time, increased levels of student proficiency on related training system measures, and no increase in retraining time.

A. Are there topics or objectives where the availability of EEMT might reduce time to train because of its individualization or other capabilities?

Are there any problems in measuring potential time savings during the test and evaluation?

Please identify the objectives that will provide EEMT segments that can be measured for possible decreases in training time by marking "A" in column VI of the tentative EEMT curriculum outline.

B. Do any of the objectives address areas where student proficiency is a problem and EEMT might show gains?

Are there areas in the curriculum that require consistent remediation or academic setbacks?

Please identify the objectives that will provide EEMT segments to increase student proficiency by marking "B" in column VI of the tentative EEMT curriculum outline.

C. A performance goal specified in the operational requirement calls for EEMT to provide individualized, adaptive instruction to accommodate the instructional needs of slow, moderate, and faster learners.

Which of the objectives emphasize differences in the time required to accomplish the objective?

Are there objectives in the existing curriculum with time per task constraints?

Please identify the objectives that will provide EEMT segments to demonstrate adaptive instruction by marking "C" in column VI of the tentative EEMT curriculum outline.

D. A performance goal specified in the operational requirement calls for EEMT to increase the student-to-instructor ratio.

Do any of the objectives address areas in the existing curriculum that strain instructor resources?

Are there objectives in the existing curriculum that create scheduling problems or bottlenecks in the pipeline?

Could EEMT ease instructional management considerations in these areas?

Please identify these objectives by marking "D" in column VI of the tentative EEMT curriculum outline.

INTRODUCTION TO TENTATIVE EEMT CURRICULUM OUTLINE

The tentative EEMT curriculum outline contains objectives from the ET and EW "A" school curricula that meet the following criteria:

1. Focus on generic systems training to capitalize on the high degree of commonality of maintenance tasks, signal processing functions, and subsystem relationships that exist within families of electronic equipment, and

2. Represent generic tasks that form a common core of instruction between ET and EW schools, as well as generic tasks unique to the ET or EW curriculum.

Appendix A to the tentative EEMT curriculum outline cross-references the EEMT objectives to the EW and ET "A" school curricula by objective numbers. Appendices B and C cross-reference the EW and ET objectives, respectively, to the EEMT objectives by objective number and a brief description of the topic area. Where possible, the number of classroom and laboratory hours currently allocated for the EW and ET objectives are listed in Appendices B and C.

The tentative EEMT curriculum outline is organized into four units containing lessons that group objectives with related content. These units and lessons are derived from the equipment commonality analysis performed by Honeywell during the system definition phase of the program.

The tentative EEMT curriculum outline is formatted to allow responses to the six structured questions to be recorded directly on the outline across from the objectives. Each EEMT objective is tentatively identified as either a 2D or 3D application. These determinations and possible 2D/3D combinations should be considered when reviewing and critiquing the content of the objectives.

APPENDIX B

FINAL ET "A" SCHOOL EEMT CURRICULUM OUTLINE

INTRODUCTION

This EEMT syllabus is to be used in conjunction with the lock-step instruction of the ET Class "A" school courses A100-0062, A100-0063, A100-0064, and A100-0066. It will include application of tutorial exercises for learning system functional theories and hands-on exercises in system operation, alignment, and fault isolation. This EEMT syllabus is intended for use during the test and evaluation phase of the EEMT system development. It is designed to test the EEMT system capabilities over a wide range of ET school applications. After successful test and evaluation, the EEMT system can be used in wider applications in the ET Class "A" school with on-site inputs to the EEMT system data base by the instructor's console. This syllabus provides a wide range of applications for the EEMT system but does not approach the total capabilities of the EEMT system because of the time constraints of the test and evaluation phase.

UNIT/MODULE A. Communications System Maintenance Tasks

Estimated Contact Hours: 44.0 Hours

LESSON TOPIC A.1.1. EEMT System Operation

Estimated Contact Hours: 3 Hours

Terminal Objective:

There is no terminal objective for this topic; it supports all terminal objectives.

Enabling Objectives:

A.1.1.1 Given the EEMT system and a technical manual, set up the EEMT system without error or omission.

A.1.1.2 Given the EEMT system and a technical manual, verify the operational status of the EEMT communications system with 100 percent accuracy.

A.1.1.3 Given the EEMT system and a technical manual, verify the operational status of the EEMT radar system with 100 percent accuracy.

LESSON TOPIC A.2.1. Transmitter Functional Operation

Estimated Contact Hours: 6 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topics A.2.2, A.2.3, and A.2.4.

2.0 Given tools, test equipment, technical manual, and the EEMT SSB transmitter, isolate a malfunction to the faulty stage. A minimum score of 75 percent must be achieved.

Enabling Objectives:

A.2.1.1 Given single sideband transmission terms and definitions, match the terms to their definition with 100 percent accuracy.

A.2.1.2 Given a spectrum drawing of an amplitude modulated signal with its signal components labeled, select the signal components whose removal would produce a single sideband suppressed carrier signal with 100 percent accuracy.

A.2.1.3 Given a group of spectrum drawings representing input signals to an AM receiver and a list of receiver audio output signal descriptions, match the audio output description with its AM receiver input signal with 100 percent accuracy.

A.2.1.4 Given a list of functions and a block diagram of the EEMT SSB transmitter, match the functions to each functional block of the EEMT SSB transmitter. The standard is 100 percent.

LESSON TOPIC A.2.2. SSB Transmitter Operation

Estimated Contact Hours: 6 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topics A.2.3 and A.2.4.

2.0 Given tools, test equipment, technical manual, and the EEMT SSB transmitter, isolate a malfunction to the faulty stage. A minimum score of 75 percent must be achieved.

Enabling Objectives:

A.2.2.1 Given a technical manual and the EEMT radio transmitter, perform the initial turn-on procedures in accordance with instructions in the technical manual without error or omission.

A.2.2.2 Given test equipment, technical manual, and the EEMT radio transmitter, perform antenna tuning procedures in accordance with the alignment instructions in the technical manual without error or omissions.

A.2.2.3 Given a technical manual and the EEMT radio transmitter, perform the operating procedures of the transmitter in accordance with instructions in the technical manual without error or omission.

LESSON TOPIC A.2.3. SSB Transmitter Alignment

Estimated Contact Hours: 6 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topic A.2.4.

2.0 Given tools, test equipment, technical manual, and the EEMT SSB transmitter, isolate a malfunction to the faulty stage. A minimum score of 75 percent must be achieved.

Enabling Objective:

A.2.3.1 Given tools, test equipment, technical manuals, and the EEMT radio transmitter, align the transmitter in accordance with the alignment instructions in the technical manual without error or omission.

LESSON TOPIC A.2.4. SSB Transmitter Fault Isolation

Estimated Contact Hours: 11 Hours

Terminal Objective:

2.0 Given tools, test equipment, technical manual, and the EEMT SSB transmitter, isolate a malfunction to the faulty stage. A minimum score of 75 percent must be achieved.

Enabling Objective:

A.2.4.1 Given tools, test equipment, a functional block diagram of the EEMT radio transmitter, EEMT transmitter, and four sets of symptoms, select the block of the prefaulted EEMT transmitter that could cause the symptoms in three of four attempts.

LESSON TOPIC A.3.1. SSB Receiver Functional Operation

Estimated Contact Hours: 3 Hours

Terminal Objective:

Supported by this lesson topic and by lesson topics A.3.2., A.3.3, and A.3.4.

3.0 Given tools, test equipment, technical manual, and the EEMT SSB receiver prefaulted with a single malfunction, isolate the malfunction to the faulty stage. A minimum score of 75 percent must be achieved.

Enabling Objective:

A.3.1.1 Given a block diagram of the EEMT SSB receiver and a list of functions, select the functions of each functional block of the receiver with 100 percent accuracy.

LESSON TOPIC A.3.2. SSB Receiver Test and Measurements

Estimated Contact Hours: 3 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topics A.3.3 and A.3.4.

3.0 Given tools, test equipment, technical manual, and the EEMT SSB receiver prefaulted with a single malfunction, isolate the malfunction to the faulty stage. A minimum score of 75 percent must be achieved.

Enabling Objectives:

A.3.2.1 Given a technical manual and the EEMT SSB receiver, perform initial turn on procedures in accordance with instructions in the technial manual without error or omission.

A.3.2.2 Given tools, test equipment, technical manual, and the EEMT SSB receiver, perform test and measurements of the receiver in accordance with instructions in the technical manual without error or omission.

LESSON TOPIC A.3.3. SSB Receiver Alignment

Estimated Contact Hours: 3 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topic A.3.4.

3.0 Given tools, test equipment, technical manual, and the EEMT SSB receiver prefaulted with a single malfunction, isolate the malfunction to the faulty stage. A minimum score of 75 percent must be achieved.

Enabling Objective:

A.3.3.1 Given tools, test equipment, technical manual, and the EEMT SSB receiver, align the receiver in accordance with the alignment instructions in the technical manual without error or omission.

LESSON TOPIC A.3.4. SSB Receiver Fault Isolation

Estimated Contact Hours: 3 Hours

Terminal Objective:

3.0 Given tools, test equipment, technical manual, and the EEMT SSB receiver prefaulted with a single malfunction, isolate the malfunction to the faulty stage. A minimum score of 75 percent must be achieved.

Enabling Objective:

A.3.4.1 Given the EEMT SSB receiver prefaulted with a single malfunction, isolate the malfunction to a faulty stage in three of four attempts.

UNIT/MODULE B. Radar System Maintenance Tasks

Estimated Contact Hours: 25.0 Hours

Terminal Objectives:

Supported entirely by this unit.

4.0 Given the EEMT radar set with a prefaulted receiver circuit, tools, test equipment, and technical manual, troubleshoot the radar receiver circutry to the following faulty circuits:

Local oscillator
Receiver IF strip
Video FTC
Receiver AFC
STC/receiver gain
IAGC
Receiver/AFC metering

5.0 Given the EEMT radar set with a prefaulted DC power supply, tools, test, and technical manual, troubleshoot the positive and negative regulated DC power supply circuits. A minimum score of 75 percent must be achieved.

LESSON TOPIC B.4.1. Radar System Operation

Estimated Contact Hours: 6.5 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topics B.4.2, B.4.3, and B.4.4.

4.0 Given the EEMT radar set with a prefaulted receiver circuit, tools, test equipment, and technical manual, troubleshoot the radar receiver circuitry to the following faulty circuit:

Local oscillator
Receiver IF strip
Video FTC
Receiver AFC
STC/receiver gain
IAGC
Receiver/AFC metering

Enabling Objective:

B.4.1.1 Given the EEMT radar system and a technical manual, perform radar turn on operation and adjustment in accordance with the technical manual without errors or omissions.

LESSON TOPIC B.4.2. Radar Receiver Test and Measurements

Estimated Contact Hours: 3 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topic B.4.3 and B.4.4.

4.0 Given the EEMT radar set with a prefaulted receiver circuit, tools, test equipment, and technical manual, troubleshoot the radar receiver circuitry to the following faulty circuits:

Local oscillator
Receiver IF strip
Video FTC
Receiver AFC
STC/receiver gain
IAGC
Receiver/AFC metering

Enabling Objective:

B.4.2.1 Given tools, test equipment, technical manual, and the EEMT radar system, measure the receiver (MDS) minimum discernible signal in accordance with the technical manual without errors or omissions.

LESSON TOPIC B.4.3. Radar System Alignment

Estimated Contact Hours: 3 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topic B.4.4.

4.0 Given the EEMT radar set with a prefaulted receiver circuit, tools, test equipment, and technical manual, troubleshoot the radar receiver circuitry to the following faulty circuits:

Local oscillator
Receiver IF strip
Video FTC
Receiver AFC
STC/receiver gain
IAGC
Receiver/AFC metering

Enabling Objective:

B.4.3.1 Given the EEMT radar system, tools, test equipment, and a technical manual, perform radar system alignment procedure to tolerances outlined in the technical manual without errors or omissions.

LESSON TOPIC B.4.4. Radar Receiver Fault Isolation

Estimated Contact Hours: 6 Hours

Terminal Objective:

4.0 Given the EEMT radar set with a prefaulted receiver circuit, tools, test equipment, and technical manual, troubleshoot the radar receiver circuitry to the following faulty circuits:

Local oscillator
Receiver IF strip
Video FTC
Receiver AFC
STC/receiver gain
IAGC
Receiver/AFC metering

Enabling Objective:

B.4.4.1 Given tools, test equipment, technical manual, and a prefaulted EEMT radar system, troubleshoot the radar receiver in accordance with the technical manual to the following faulty circuits in three of four attempts.

Local oscillator
Receiver IF strip
Video FTC
Receiver AFC
STC/receiver gain
IAGC
Receiver/AFC metering

LESSON TOPIC B.5.1. Radar DC Power Supply Adjustment

Estimated Contact Hours: 4.5 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topic B.5.2.

5.0 Given the EEMT radar set with a prefaulted DC power supply, tools, test equipment, and technical manual, troubleshoot the positive and negative regulated DC power supply circuits. A minimum score of 75 percent must be achieved.

Enabling Objectives:

B.5.1.1 Given test equipment, technical manual, and the EEMT power supply, record the EEMT power supply voltages in accordance with the instructions specified in the technical manual without error or omission.

B.5.1.2 Given tools, test equipment, technical manual, and the EEMT power supply, adjust the EEMT power supply in accordance with the instructions in the technical manual without error or omission.

LESSON TOPIC B.5.2. Radar DC Power Supply Fault Isolation

Estimated Contact Hours: 2 Hours

Terminal Objective:

5.0 Given the EEMT radar set with a prefaulted DC power supply, tools, test equipment, and technical manual, troubleshoot the positive and negative regulated DC power supply circuits. A minimum score of 75 percent must be achieved.

Enabling Objective:

B.5.2.1 Given tools, test equipment, a functional block diagram of the EEMT power supply, EEMT power supply, and four sets of symptoms, select the component of the prefaulted EEMT power supply that could cause the symptoms in three of four attempts.

APPENDIX C

FINAL EW "A" SCHOOL EEMT CURRICULUM OUTLINE

INTRODUCTION

This EEMT syllabus is to be used in conjunction with the lock-step instruction of the EW Class "A" school. It will include application of tutorial exercises for learning system functional theories and hands-on exercises in system operation, alignment, and fault isolation. This EEMT syllabus is intended for use during the test and evaluation phase of the EEMT system development. It is designed to test the EEMT system capabilities over a wide range of EW school applications. After successful test and evaluation, the EEMT system can be used in wider applications in the EW Class "A" school with on-site inputs to the EEMT system data base by the instructor's console. This syllabus provides a wide range of applications for the EEMT system but does not approach the total capabilities of the EEMT system because of the time constraints of the test and evaluation phase.

UNIT MODEL A. Test Equipment Operation

Estimated Contact Hours: 15.0 Hours

Terminal Objective:

Supported entirely by this unit.

1.0 Given an oscilloscope, RF signal generator, universal counter, digital voltmeter, power meter, spectrum analyzer, technial manual, and a jobsheet, measure signal functions of time, frequency, amplitude, phase relationship, or power to the tolerance specified on the jobsheet. A minimum score of 70 percent must be achieved.

LESSON TOPIC A.1.1. EEMT System Operation

Estimated Contact Hours: 3 Hours

Terminal Objective:

There is no terminal objective for this topic; it supports all terminal objectives.

Enabling Objectives:

A.1.1.1 Given the EEMT system and a technical manual, set up the EEMT system without error or omission.

A.1.1.4 Given the EEMT system and a technical manual, verify the operational status of the EEMT ESM system with 100 percent accuracy.

LESSON TOPIC A.1.2. Test Equipment Operation

Estimated Contact Hours: 12.0 Hours

Terminal Objective:

Supported entirely by this lesson topic.

1.0 Given an oscilloscope, RF signal generator, universal counter, digital voltmeter, power meter, spectrum analyzer, technical manual, and a jobsheet, measure signal functions of time, frequency, amplitude, phase relationship, or power to the tolerance specified on the jobsheet. A minimum score of 70 percent must be achieved.

Enabling Objectives:

A.1.2.1 Given the EEMT oscilloscope, a jobsheet, and seven EEMT generated signals, measure the amplitude, time, frequency, and phase relationship on five of the seven signals within the tolerance specified on the jobsheet.

A.1.2.2 Given the EEMT oscilloscope, RF signal generator, jobsheet, and a list of four waveforms, produce output voltage waveforms to the tolerance specified on the jobsheet in three of four attempts.

A.1.2.3 Given the EEMT universal counter, a jobsheet, and seven EEMT generated signals, measure the frequency on five of the seven signals within the tolerance specified on the jobsheet.

A.1.2.4 Given the EEMT digital voltmeter and four EEMT generated voltages, measure the value of three of four voltages to an accuracy of ±.5 percent.

A.1.2.5 Given the EEMT power meter and four EEMT generated signals, measure the output power of three of the four signals to an accuracy of ±.1 percent.

A.1.2.6 Given the EEMT spectrum analyzer, a jobsheet, and four EEMT generated signals, operate the spectrum analyzer to display the test signals specified on the jobsheet in three of four attemtps.

UNIT/MODULE C. Electronic Warfare System Maintenance Tasks

Estimated Contact Hours: 25.5 Hours

Terminal Objectives:

Supported entirely by this unit.

6.0 Given the EEMT ESM system, tools, test equipment, and technical manual, perform ESM system maintenance tasks without errors or ommission within 1.5 times the time indicated on the MRC.

7.0 Given the EEMT ESM system, tools, test equipment, and technical manual, perform ESM system power supply maintenance tasks without errors or omissions within 1.5 times the time indicated on the MRC.

LESSON TOPIC C.6.1. ESM System Operation

Estimated Contact Hours: 4 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topic C.6.2 and C.6.3.

6.0 Given the EEMT ESM system, tools, test equipment, and technical manual, perform ESM system maintenance tasks without errors or omission within 1.5 times the time indicated on the MRC.

Enabling Objective:

C.6.1.1 Given the EEMT ESM system, tools, test equipment, and technical manual, operate the ESM system in accordance with the technical manual and jobsheet instructions without errors or omissions.

LESSON TOPIC C.6.2. ESM System Measurements

Estimated Contact Hours: 10.5 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topic C.6.3.

6.0 Given the EEMT ESM system, tools, test equipment, and technical manual, perform ESM system maintenance tasks without errors or omission within 1.5 times the time indicated on the MRC.

Enabling Objectives:

C.6.2.1 Given the EEMT ESM system, tools, test equipment, and technical manual, measure the Band 1 receiver sensitivity in accordance with the MRC within 1.5 times the time specified on the MRC.

C.6.2.2 Given the EEMT ESM system, tools, test equipment, and technical manual, measure the multibeam/IFM sensitivity in accordance with the MRC within 1.5 times the time specified on the MRC.

LESSON TOPIC C.6.3. ESM System Adjustments

Estimated Contact Hours: 6.5 Hours

Terminal Objective:

6.0 Given the EEMT ESM system, tools, test equipment, and technical manual, perform ESM system maintenance tasks without errors or omission within 1.5 times the time indicated on the MRC.

Enabling Objectives:

C.6.3.1 Given the EEMT ESM system, tools, test equipment, and technical manual, perform IFM noise level adjustments in accordance with the technical manual within the time specified on the jobsheet without errors or omissions.

C.6.3.2 Given the EEMT ESM system, tools, test equipment, and technical manual, perform false alarm rate adjustment in accordance with the technical manual without errors or omissions.

C.6.3.3 Given the EEMT ESM system, tools, test equipment, and technical manual, perform ESM correlation timing adjustments in accordance with the technical manual without errors or omissions.

LESSON TOPIC C.7.1. ESM Power Supply Functional Check

Estimated Contact Hours: 4.5 Hours

Terminal Objective:

Supported entirely by this lesson topic.

7.0 Given the EEMT ESM system, tools, test equipment, and technical manual, perform ESM system power supply maintenance tasks without errors or omissions within 1.5 times the time indicated on the MRC.

Enabling Objectives:

C.7.1.1 Given the EEMT ESM system, tools, test equipment, and technical manual, perform a power supply functional check to the tolerance specified on the jobsheet without errors or omissions.

C.7.1.2 Given the EEMT ESM system, tools, test equipment, and technical manual, align the power supply in accordance with the MRC without errors or omissions within 1.5 times the time specified on the MRC.

APPENDIX D

FINAL AN/SPS-10 CURRICULUM OUTLINE

INTRODUCTION

This EEMT syllabus is to be used in conjunction with the lock-step instruction of the ET Class "A" school. It will include application of tutorial exercises for learning system functional theories and practice in procedures required for system operation and fault isolation. This EEMT syllabus is intended for use during the test and evaluation phase of EEMT system development. After successful test and evaluation, the EEMT system can be used in wider applications in the ET Class "A" school with on-site inputs to the EEMT system data base by the instroctor's console.

UNIT MODULE 1. AN/SPS-10 Radar System Maintenance Tasks

Estimated Contact Hours: 20 Hours

Terminal Objectives:

1.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 radar set to the faulty component. A minimum score of 75 percent must be achieved.

2.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 primary power circuit to the faulty component part. A minimum score of 75 percent must be achieved.

3.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 voltage regulator to the faulty component part. A minimum score of 75 percent must be achieved.

4.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 modulator to the faulty component part. A minimum score of 75 percent must be achieved.

5.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 receiver transmitter to the faulty component part. A minimum score of 75 percent must be achieved.

LESSON TOPIC 1.1. AN/SPS-10 Operation

Estimated Contact Hours: 5.5 Hours

Terminal Objective:

1.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 radar set to the faulty component. A minimum score of 75 percent must be achieved.

Enabling Objectives:

1.1.1 Given the EEMT system, a technical manual, and a jobsheet, locate without error the component parts of each of the following units of the AN/SPS-10 radar set listed on the jobsheet.

Modulator
Power supply
AC voltage regulator
Indicator adapters
Receiver/transmitter
Interconnecting box
Radar set control

1.1.2 Given the EEMT system, the AN/SPS-10 radar set technical manual, and a list of radar set controls, select the control that is identified by statements describing control effects on transmitted or received pulses. The standard is 100 percent.

1.1.3 Given the EEMT system and the AN/SPS-10 radar set technical manual, perform turn on/off and adjustment of controls for optimum visual display of input video.

1.1.4 Given the EEMT system, a technical manual, a list of purpose/functions, and a block diagram of the AN/SPS-10 radar set, match the purpose/function to the following units of the AN/SPS-10 radar set.

Modulator
Power supply
AC voltage regulator
Indicator adapters
Receiver/transmitter
Interconnecting box
Radar set control

1.1.5 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 radar set to the faulty component. Three out of four faulty components must be isolated.

LESSON TOPIC 1.2. AN/SPS-10 Primary Power Fault Isolation

Estimated Contact Hours: 5.0 Hours

Terminal Objective:

2.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 primary power circuit to the faulty component part. A minimum score of 75 percent must be achieved.

Enabling Objective:

1.2.1 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 primary power circuit and 24VDC control distribution circuit to the faulty component part. A minimum score of 75 percent must be achieved.

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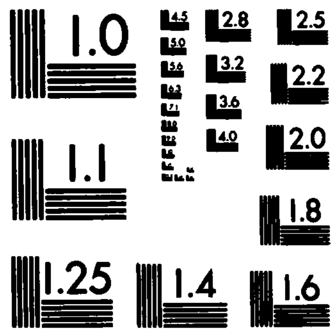
1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

LESSON TOPIC 1.3. AN/SPS-10 Voltage Regulator Fault Isolation

Estimated Contact Hours: 3.0 Hours

Terminal Objective:

3.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 voltage regulator to the faulty component part. A minimum score of 75 percent must be achieved.

Enabling Objective:

1.3.1 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 AC voltage regulator to a faulty component part. A minimum score of 75 percent must be achieved.

LESSON TOPIC 1.4. AN/SPS-10 Modulator Fault Isolation

Estimated Contact Hours: 5.0 Hours

Terminal Objective:

Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 modulator to the faulty component part. A minimum score of 75 percent must be achieved.

Enabling Objectives:

1.4.1 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the modulator vacuum tube trigger pulse generator to the faulty component part. A minimum score of 75 percent must be achieved.

1.4.2 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the modulator pulse generator to the faulty component part. A minimum score of 100 percent must be achieved for safety procedures in isolating three of four faults.

LESSON TOPIC 1.5. AN/SPS-10 Receiver/Transmitter Fault Isolation

Estimated Contact Hours: 1.5 Hours

Terminal Objective:

5.0 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the AN/SPS-10 receiver transmitter to the faulty component part. A minimum score of 75 percent must be achieved.

Enabling Objective:

1.5.1 Given the EEMT system, a technical manual, and a set of symptoms, perform fault isolation of the transmitter metering section to a faulty component part. A minimum score of 75 percent must be achieved.

APPENDIX E

FINAL AN/WSC-3 EEMT CURRICULUM OUTLINE

INTRODUCTION

This EEMT syllabus is to be used in conjunction with the lock-step instruction of the ET Class "A" school. It will include application of tutorial exercises for learning system functional theories and practice in procedures required for system operation and fault isolation. This EEMT syllabus is intended for use during the test and evaluation phase of EEMT system development. After successful test and evaluation, the EEMT system can be used in wider applications in the ET Class "A" school with on-site inputs to the EEMT system data base by the instructor's console.

UNIT MODULE 1. AN/WSC-3 System Maintenance Tasks

Estimated Contact Hours: 30.0 Hours

Terminal Objectives:

1.0 Given a technical manual, a half-duplex UHF AFTS single channel RATT communications circuit, and the EEMT system, isolate a malfunction to a faulty componet. A minimum score of 75 percent must be achieved.

2.0 Given a technical manual and the EEMT system, operate the AN/WSC-3 communications set in all modes of operation in accordance with instructions in the technical manual without error or omission.

3.0 Given technical manuals and the EEMT system, isolate a malfunction to a faulty module in the AN/WSC-3 system. A minimum score of 75 percent must be achieved.

LESSON TOPIC 1.0. UHF AFTS Single-Channel System

Estimated Contact Hours: 9.0 Hours

Terminal Objective:

1.0 Given a technical manual, a half-duplex UHF AFTS single-channel RATT communications circuit, and the EEMT system, isolate a malfunction to a faulty component. A minimum score of 75 percent must be achieved.

Enabling Objectives:

1.1 Given a list of component functions and a block diagram of a half-duplex UHF AFTS single-channel RATT communications circuit, match the functions to each block of the circuit with 100 percent accuracy.

1.2 Given a list of module functions and a block diagram of the AN/WSC-3 receiver transmitter, match the functions to each block of the receiver transmitter without errors or omissions.

1.3 Given a list of module functions and a block diagram of the AN/WSC-3 control indicator, match the function to each block of the control indicator without error or omission.

1.4 Given a block diagram of a half-duplex UHF AFTS single channel RATT communication circuit, the EEMT system, and a set of symptoms, select the component that could cause the symptoms in three of four attemtps.

LESSON TOPIC 2.0. AN/WSC-3 Operation

Estimated Contact Hours: 6.0 Hours

Terminal Objective:

2.0 Given a technical manual and the EEMT system, operate the AN/WSC-3 communications set in all modes of operation in accordance with instructions in the technical manual without error or omission.

Enabling Objectives:

2.1 Given sets of characteristics identifying frequency range, modes of operation, bandwidth, and power out, select the set that identifies the charactristics of the AN/WSC-3. The standard is 100 percent.

2.2 Given a list of functional descriptions and an illustration of the AN/WSC-3 operating controls and indicators, match the description to the operating controls and indicators with 100 percent accuracy.

2.3 Given a technical manual and the EEMT system, perform the operating procedures of the AN/WSC-3 in accordance with instructions in the technical manual without error or omission.

LESSON TOPIC 3.0. AN/WSC-3 Fault Isolation

Estimated Contact Hours: 15.0 Hours

Terminal Objective:

3.0 Given technical manuals and the EEMT system, isolate a malfunction to a faulty module in the AN/WSC-3 system. A minimum score of 75 percent must be achieved.

Enabling Objectives:

3.1 Given a functional block diagram of the AN/WSC-3 receiver transmitter, the EEMT system, and a set of symptoms, select the module block of the receiver transmitter that could cause the symptoms in three of four attempts.

3.2 Given a functional block diagram of the AN/WSC-3 control indicator, the EEMT system, and a set of symptoms, select the block of the control indicator that could cause the symptoms in three of four attempts.

APPENDIX F

FINAL AN/SLQ-32 EEMT CURRICULUM OUTLINE

INTRODUCTION

This EEMT syllabus is to be used in conjunction with the lock-step instruction of the EW Class "A" school. It will include application of tutorial exercises for learning system functional theories and practice in procedures required for system operation and alignment. This EEMT syllabus is intended for use during the test and evaluation phase of EEMT system development. After successful test and evaluation, the EEMT system can be used in wider applications in the EW Class "A" school with on-site inputs to the EEMT system data base by the instructor's console.

UNIT 1/MODULE 1. ESM System Maintenance

Estimated Contact Hours: 44 Hours

Terminal Objectives:

1.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 scheduled maintenance tests in accordance with technical manual without errors or omissions.

2.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 Receiver-DCU alignment in accordance with the technical manual without errors or omissions.

3.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 BIT correlation and timing adjustments in accordance with the technical manual without errors or omissions.

4.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 encoder tests in accordance with the technical manual without errors or omissions.

5.0 Given the EEMT system and a techical manual, perform AN/SLQ-32 Bands 2 and 3 scheduled maintenance checks and alignments in accordance with the technical manual without errors or omissions.

LESSON TOPIC 1.1. System Diagnostic Test

Estimated Contact Hours: 3.0 Hours

Terminal Objective:

Supported partially by this lesson topic and by lesson topic 1.2.

1.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 scheduled maintenance tests in accordance with technical manual without errors or omissions.

Enabling Objective:

1.1 Given the EEMT system and a technical manual, perform AN/SLQ-32 system diagnostic tests in accordance with MRC (3D-1R) without errors or omissions within 1.5 times the time allotted on the MRC.

LESSON TOPIC 1.2. Sensitivity Tests

Estimated Contact Hours: 8.5 Hours

Terminal Objective:

1.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 scheduled maintenance tests in accordance with technical manual without errors or omissions.

Enabling Objective:

1.2.1 Given the EEMT system and a technical manual, perform AN/SLQ-32 IFM and DFR sensitivity tests in accordance with MRC (M-1) without errors or omissions within 1.5 times the time allotted on the MRC.

LESSON TOPIC 1.3. Band 1 Receiver-DCU Test and Alignment

Estimated Contact Hours: 10.0 Hours

Terminal Objective:

2.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 Receiver-DCU alignment in accordance with the technical manual without errors or omissions.

Enabling Objectives:

1.3.1 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 RCVR-DCU timing test in accordance with MRC (W-1R) without errors or omissions.

1.3.2 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 RCVR-DCU video threshold test in accordance with MRC (W-1R) without errors or omissions.

1.3.3 Given the EEMT system and a techical manual, perform AN/SLQ-32 Band 1 RCVR-DCU pulse/CW threshold test in accordance with MRC (W-1R) without errors or omissions.

1.3.4 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 amplitude encoding alignment in accordance with MRC (W-1R) without errors or omissions.

1.3.5 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 YIG VCO tuning end points adjustment in accordance with MRC (W-1R) without errors or omissions.

1.3.6 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 video threshold adjustment in accordance with MRC (W-1R) without errors or omissions.

1.3.7 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 Log video balance adjustment in accordance with MRC (W-1R) without errors or omissions.

1.3.8 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 Center guard band alignment in accordance with MRC (W-1R) without errors or omissions.

1.3.9 Given the EEMT system and a technical manual, perform the following AN/SLQ-32 Band 1 threshold adjustments in accordance with MRC (W-1R) without errors or omissions.

BIT amplitude
LO power level
Pulse/CW

LESSON TOPIC 1.4. BIT Correlation and Timing

Estimated Contact Hours: 6.5 Hours

Terminal Objective:

3.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 BIT correlation and timing adjustments in accordance with the technical manual without errors or omissions.

Enabling Objectives:

1.4.1 Given the EEMT system and a technical manual, perform AN/SLQ-32 BIT correlation and timing check for Bands 2 and 3 in accordance with MRC (M-5R) without errors or omissions within 1.5 times the time allotted on the MRC.

1.4.2 Given the EEMT system, jobsheet, and a technical manual, perform AN/SLQ-32 BIT correlation and timing adjustment procedures for Bands 2 and 3 in accordance with technical manual without errors or omissions within the time allotted on the jobsheet.

LESSON TOPIC 1.5. Band 1 Encoder Tests

Estimated Contact Hours: 4.0 Hours

Terminal Objective:

4.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 encoder tests in accordance with the technical manual without errors or omissions.

Enabling Objectives:

1.5.1 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 angle of arrival encoder test in accordance with MRC (M-8) without errors or omissions within 1.5 times the time allotted on the MRC.

1.5.2 Given the EEMT system and a technical manual, perform AN/SLQ-32 Band 1 amplitude encoder/log amplifier test in accordance with MRC (M-8) without errors or omissions within 1.5 times the time allotted on the MRC.

LESSON TOPIC 1.6. Bands 2 and 3 Tests and Alignment

Estimated Contact Hours: 12.0 Hours

Terminal Objective:

5.0 Given the EEMT system and a technical manual, perform AN/SLQ-32 Bands 2/3 scheduled maintenance checks and alignments in accordance with the technical manual without errors or omissions.

Enabling Objectives:

1.6.1 Given the EEMT system, MRCs, and a technical manual, perform AN/SLQ-32 IFM/CFR variable threshold check and adjustment in accordance with MRC (M-7) without errors or omissions within 1.5 times the time allotted on the MRC.

1.6.2 Given the EEMT system and a technical manual, perform AN/SLQ-32 Bands 2/3 trigger circuit thresholds and offset voltage checks and alignments in accordance with MRC (Q-1) without errors or omissions within 1.5 times the time allotted on the MRC.

1.6.3 Given the EEMT system and a technical manual, perform a check of AN/SLQ-32 Bands 2 and 3 angle encoder amplitude encoding in accordance with MRC (Q-1) without errors or omissions within 1.5 times the time allotted on the MRC.

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